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CHEMICAL ANALYSIS OF SOME PHILIPPINE FORAGE PLANTS

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In the course of our work on the inorganic constituents of Philippine food plants [1] we received numerous samples of forage crops from the Philippine Bureau of Animal Industry and other government entities. Many of these forage plants were introduced into the Islands during recent years. Cultural characteristics and future possibilities of these forage plants are given in the Fourth Annual Report (1934) of the Bureau of Animal Industry, and in Piper's paper entitled "Forage Crops and Forage Conditions in the Philippines."[2] Several other investigations [3] along this line have also been reported.

Recently we analyzed the numerous samples of forage crops we have received; the results are recorded in this paper.

EXPERIMENTAL PROCEDURE

Representative portions of the plants were first freed from all foreign matter; then the samples were air-dried, powdered, and preserved in well-stoppered bottles.

The samples were analyzed in accordance with the official agricultural methods [4] for common constituents, such as fat, protein, and crude fiber. The results are given in Table 1.

[1] Philip. Journ. Sci. 58 (1935) 317.

[2] Philip. Agri. Rev. 4 (1911) 394.

[3] Philip. Agri. Rev. 13 (1920) 353. Philip. Agri. 15 (1926–27) 547; 18 (1929–30) 125. Philip. Journ. Agri. 3 (1932) 216.

[4] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists. 4th ed. (1935).

TABLE 1.—*Approximate chemical composition of Philippine forage plants.*[a]

Name of plant. Scientific.	Name of plant. Common.	Fat.	Protein.	Ash.	Carbohydrates. N-free extract.	Carbohydrates. Crude fiber.
PASTURE GRASSES		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Coix lachryma-jobi Linn.	Adlay	6.10	7.50	3.66	59.22	23.52
Cenchrus viridis Spreng.	Agiñgai	1.27	4.44	9.33	47.61	37.35
Paspalum compressum Nees.	Carpet grass	1.43	3.87	2.61	61.12	30.97
Paspalum dilatatum Poir.	Dallis	1.90	5.63	2.46	54.71	35.30
Pennisetum clandestinum Pers.	Kikuyu	1.62	9.19	6.23	54.63	28.23
Tricholaena rosea Nees.	Natal red top	2.48	7.47	12.02	46.12	31.91
Pennisetum setosum Rich. (before flowering)		2.36	10.00	11.16	47.59	28.90
Pennisetum setosum Rich. (flowering stage)		1.68	6.59	6.80	45.93	39.00
Pennisetum setosum Rich.		1.92	6.16	10.27	60.72	20.93
Agrostis sp.	Red top	3.82	10.94	3.12	65.73	16.39
Chloris Gayana Kunth. (flowering)	Rhodes grass	1.26	7.20	2.65	51.04	37.85
Chloris Gayana Kunth.	do	1.72	7.00	4.40	52.83	34.05
Andropogon contortus Linn.	Silatadalan	1.46	5.72	10.14	42.63	40.05
Themeda triandra Forsk. (flowering stage)	Silibun grass	2.46	6.88	1.31	52.21	37.11
Melinis minutiflora Beauv.	Yaragua grass	2.08	8.94	2.49	49.20	37.29
SOILING CROPS						
Elephantopus scaber Linn.	Dila-dila	4.75	8.25	15.89	46.47	24.64
Ipomoea triloba Linn.	Balobagbug	3.06	12.50	10.41	43.26	30.77
Panicum frumentaceum Salisb. (fruiting)	Japanese millet	2.41	11.38	9.99	54.13	22.09
Holcus sp. (flowering)	Milo maize	1.90	11.25	11.50	45.53	29.72
Holcus sp. (fruiting)	do	2.69	7.31	2.16	54.72	33.12
Pennisetum purpureum Schum. (before flowering)	Napier grass	1.54	6.82	7.40	54.32	30.92
Holcus sudanensis Bailey (before flowering)	Sudan grass	2.90	10.68	11.27	42.61	32.60

Holcus sudanensis Bailey (flowering)	do	2.87	10.21	10.48	46.24	30.06
Euchlaena mexicana Schrad.	Teosinte	1.96	5.84	6.74	64.60	30.86
Saccharum sp. (before flowering)	Uba cane	2.29	6.33	4.87	54.63	32.94
LEGUMES						
Glycine hispida Maxim.	Soy-bean hay	2.78	14.28	8.40	35.75	40.74
Phaseolus calcaratus Roxb.	Tapilan bean hay	1.70	9.00	5.07	36.34	48.67
Stizolobium deeringianum Bort.	Velvet-bean hay	3.24	18.94	6.98	62.29	18.55

* Percentages based on moisture-free samples.

TABLE 2.—*Phosphorus, calcium, and iron contents of some Philippine plants.*

Name of plant.		Lime (CaO) in—		Phosphorus (P_2O_5) in—		Iron (Fe_2O_3) in—	
Scientific.	Common.	Ash.	Moisture-free sample.	Ash.	Moisture-free sample.	Ash.	Moisture-free sample.
PASTURE GRASSES		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Coix lachryma-jobi Linn.	Adlay	2.11	0.08	14.39	1.22	0.28	0.01
Cenchrus viridis Spreng.	Agingai	1.94	0.18	8.14	0.76	0.06	0.005
Paspalum compressum Nees.	Carpet grass	4.04	0.11	15.98	0.42	2.61	0.08
Paspalum dilatatum Poir	Dallis	2.89	0.07	15.98	0.39	0.68	0.02
Pennisetum clandestinum Pers.	Kikuyu	3.81	0.24	16.35	1.03	0.66	0.04
Tricholaena rosea Nees.	Natal red top	0.84	0.10	6.58	0.83	2.67	0.31
Pennisetum setosum Rich. (before flowering)		3.04	0.04	7.34	0.82	1.79	0.20
Pennisetum setosum Rich. (flowering stage)		1.61	0.11	5.01	0.35	1.61	0.11
Pennisetum setosum Rich.		0.91	0.09	8.47	0.87	6.35	0.56
Agrostis sp.	Red top	3.20	0.10	3.62	0.11	0.24	0.008
Chloris Gayana Kunth. (flowering)	Rhodes grass	11.59	0.80	19.67	0.52	0.11	0.003
Chloris Gayana Kunth.	do	5.20	0.23	15.26	0.67	0.05	0.002
Andropogon contortus Linn.	Sibat-sibatan	3.69	0.16	7.18	0.72	0.17	0.02
Themeda triandra Forsk. (flowering stage)	Ribbon grass	10.08	0.14				
Melinis minutiflora Beauv.	[illegible] grass	8.22	0.16	29.51	1.74	0.99	0.05
FORAGE CROPS							
Elephantopus scaber Linn.	Dila-dila	15.60	2.09	4.73	0.76	1.88	0.30
Ipomoea triloba Linn.	Malobagbug	8.27	0.80	15.85	1.65	1.63	0.17
Panicum frumentaceum Salisb. (fruiting)	Japanese millet	11.45	1.12	24.25	2.86	0.82	0.08
Holcus sp. (flowering)	Milo maize	11.32	1.31	21.63	2.51	0.61	0.06
Holcus sp. (fruiting)	do	8.31	0.18	3.95	0.09	0.02	0.007
Pennisetum purpureum Schum. (before flowering)	Napier grass	4.86	0.36	15.36	1.18	0.16	0.01
Holcus sudanensis Bailey (before flowering)	Sudan grass	5.49	0.62	18.04	2.02	0.10	0.01

Holcus sudanensis Bailey (flowering)	do	3.92	0.41	12.76	1.34	0.36	0.02
Euchlaena mexicana Schrad.	Teosinte			17.85	1.17	0.57	0.004
Saccharum sp. (before flowering)	Uba cane	5.30	0.28	9.26	0.45	0.36	0.007
LEGUMES							
Glycine hispida Maxim.	Soy-bean hay	13.00	1.22	11.48	0.74	0.31	0.02
Phaseolus calcaratus Roxb.	Tapilan-bean hay	18.48	1.47	8.19	0.65	0.59	0.06
Stizolobium deeringianum Bort.	Velvet-bean hay			8.81	0.62	0.27	0.02

Analyses were also made for the calcium, phosphorus, and iron contents of the samples; the data are recorded in Table 2.

For the systematic presentation of our results the plants were classified into pasture grasses, silage crops, and legumes.

PASTURE GRASSES

The fat constituent (ether extract) of the pasture grasses varied considerably. Thus adlay (*Coix lachryma jobi* Linn.) contained 6.10 per cent fat, whereas agingai (*Cenchrus viridis* Spreng.) had only 1.27 per cent (Table 1).

The fiber content ranged from 16.89 per cent in red top (*Agrostis* sp.) to 40.06 per cent in sibat-sibatan (*Andropogon contortus* Linn.). A number of the samples contained from 30.93 to 40.06 per cent crude fiber.

Carpet grass (*Paspalum compressum* Nees.) had the lowest protein content, 3.87 per cent, while red top had the highest, 10.94 per cent. The average for most of the samples ranged from 5.63 to 8.94 per cent protein.

The lowest amount of ash, 1.34 per cent, was found in silibon grass (*Themeda triandra* Forsk.) and the highest, 12.02 per cent, in natal red top (*Tricholaena rosea* Nees). Eight samples contained from 1.34 to 4.40 per cent ash.

The percentage of nitrogen-free extract ran from 42.63 in *Andropogon contortus* to 65.73 in red top, with most of the samples giving 46.12 to 54.71 per cent.

The phosphorus, calcium, and iron contents (Table 2) of the pasture grasses were extremely variable. Of the fifteen samples analyzed, eight had from 0.10 to 0.19 per cent lime (CaO), six from 0.40 to 0.79 per cent phosphorus (P_2O_5), and seven from 0.005 to 0.04 per cent iron (Fe_2O_3) (Table 4). As a whole the pasture grasses contained more phosphorus than calcium.

SILAGE CROPS

The fat contained in the silage crops varied from 1.54 per cent in napier grass to 4.75 per cent in dila-dila (*Elephantopus scaber* Linn.).

The fiber content was not as variable as that found in pasture grasses, many samples containing from 29.72 to 33.13 per cent.

The percentage of crude protein in the silage crops ranged from 5.38 in Japanese cane (*Saccharum* spp.) to 12.50 in halobagbug (*Ipomoea triloba*).

There was quite a difference in the ash content of the silage crops. Milo maiz (fruiting stage) contained 2.15 per cent ash, while dila-dila (*Elephantopus scaber*) had 15.89.

Numerous samples gave a nitrogen-free extract of 45.53 to 54.72 per cent.

There was a considerable difference in the percentage composition of some samples collected at different physiological periods. Thus milo maiz in the flowering period had 1.90 per cent fat and 11.25 per cent protein. The same plant in the fruiting period contained 2.69 per cent fat and 7.31 per cent protein.

LEGUMES

The legumes as usual contained the highest percentage of protein. Thus velvet-bean hay and soy-bean hay had 13.94 and 14.38 per cent of protein respectively.

DISTRIBUTION OF PLANTS ACCORDING TO COMPOSITION

Table 3 shows the general distribution of forage plants in accordance with the percentage of chemical constituents determined by the customary food analysis.

The distribution of forage plants according to phosphorus, calcium, and iron contents is given in Table 4.

SUMMARY

The proximate chemical composition of some forage plants recently introduced into the Philippines was determined.

Most of the pasture grasses gave 1.26 to 1.92 per cent fat, 30.93 to 40.06 per cent crude fiber, 5.63 to 8.94 per cent protein, and 46.12 to 54.71 per cent carbohydrates.

The majority of the silage crops contained from 2.29 to 2.90 per cent fat, 29.72 to 33.13 per cent crude fiber, 5.38 to 10.68 per cent protein, 45.53 to 54.72 per cent carbohydrates.

Legumes were relatively rich in protein.

There is a wider range of calcium and iron content in pasture grasses than in silage crops and legumes.

The silage crops are relatively higher in phosphorus than the pasture grasses.

ACKNOWLEDGMENT

Thanks are due to Dr. Segundo Alano, of the Philippine Bureau of Animal Industry, for his kindness in furnishing us a number of samples reported in this paper.

TABLE 3.—*Distribution of forage plants according to the percentage of their chemical constituents.*[a]

PASTURE GRASSES

Fat.		Crude fiber.		Protein.		Ash.		N-free extract.	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
9	1.26–1.92	1	16.89–23.00	2	3.87–4.44	8	1.84–4.40	2	42.65–45.98
4	2.08–2.48	3	23.52–25.90	10	5.63–8.94	3	6.27–9.33	10	46.12–54.71
2	3.32–6.10	11	30.93–40.06	3	9.19–10.94	4	10.14–12.02	3	59.32–66.38

SILAGE CROPS AND LEGUMES

Fat.		Crude fiber.		Protein.		Ash.		N-free extract.	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
4	1.54–1.95	3	18.53–24.64	8	6.33–10.68	2	2.15–4.87	2	31.36–35.75
6	2.29–2.99	8	29.72–33.18	3	11.25–12.60	6	6.40–9.75	2	42.65–43.26
3	3.56–4.76	2	40.74–45.87	2	14.38–18.94	5	10.41–15.83	9	45.53–54.72

[a] Percentages based on moisture-free samples.

TABLE 4.—*Distribution of forage plants according to phosphorus, calcium, and iron contents.*[a]

PASTURE GRASSES

Lime (CaO).		Phosphorus (P_2O_5).		Iron (Fe_2O_3).	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
3	0.07-0.09	3	0.11-0.39	2	0.003-0.004
8	0.10-0.19	6	0.40-0.79	7	0.005-0.04
2	0.20-0.29	3	0.80-0.99	1	0.05-0.10
2	0.30-0.34	2	1.00-1.02	4	0.11-0.55

SILAGE CROPS AND LEGUMES[a]

Lime (CaO).		Phosphorus (P_2O_5).		Iron (Fe_2O_3).	
Samples.	Per cent.	Samples.	Per cent.	Samples.	Per cent.
3	0.18-0.26	2	0.39-0.45	3	0.004-0.007
2	0.41-0.62	7	0.62-1.34	5	0.01-0.02
5	0.86-1.49	9	1.65-2.06	3	0.05-0.08
1	2.00-2.08	1	2.50-2.61	2	0.12-0.30

[a] Percentages based on moisture-free samples.

THE SIGNIFICANCE OF COMPARATIVE ANATOMY IN ESTABLISHING THE RELATIONSHIP OF THE HYPERICACEÆ TO THE GUTTIFERÆ AND THEIR ALLIES.[1]

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NINE PLATES AND THREE TEXT FIGURES

INTRODUCTION

The problem forming the subject of this paper grew out of an attempt to harmonize taxonomy and anatomy in the allocation of the Hypericaceæ. It early became evident that no attack on the problem could be complete without some knowledge of the relationship of the Guttiferæ to those families which have at one time or another been allied to it, and of the position of this group in a phylogenetic system of the angiosperms.

In order to understand any system of classification, one must know something about the fundamentals upon which the system is based. In the angiosperms the structure of the flower is generally considered to be fundamental. Increasing knowledge of floral morphology has resulted in various attempts to reconstruct a natural system; these attempts have been aided by the introduction of other external morphological characters as they were better understood.

The introduction of the anatomical method has gone hand in hand with the development of the microscope and of the technic of preparing and cutting anatomical tissues. Certain anatomical characters have long been used in the allocation of specific groups of plants, but only because they have an external expression that can be utilized without further investigation; for example, glands and leaf venation. The development of the anatomical method has given precision to these characters and has furnished new ones. Their study indicates variations. We assume phyletic trends in the external morphology, why not in the internal? It is recognized that floral evolution has been activated in a considerable measure by the intimate relationship of insects to pollina-

[1] Contribution from the Laboratory of Plant Morphology, Harvard University.

tion. It is recognized also that anatomical evolution, more particularly that of the stelar tissues, must have a morphophysiological background rather than that to be ascribed to floral evolution. Can evidence accruing from comparative anatomical study be of value in the clarification of the problem of constructing a natural system on general morphological grounds?

The use of vascular anatomy as an aid in classification is not new, but it requires an enormous amount of work. Consequently it has been restricted to those anatomists who may also have an interest in phylogeny. Great strides have been made in this direction since the time of Hofmeister,(56) principally through the work of Solereder.(104) The primary task is to determine the course of modification in related forms and the relationships existing between them. Both external and internal morphology are the product of at least two factors, heredity and environment. One must determine first those characters which have been acquired independently of the external conditions and therefore may be of phyletic value, and secondly, those that may be due to biological or physiological factors. Observers agree that similarity of structure need not indicate community of descent. Thus the variable characters of phyletic value remain the sole basis of this kind of work.

In anatomy as in taxonomy the way becomes clearer as more and more groups are known. That the plant has developed as a whole is granted. Therefore the trends in the internal structure should be considered, if a natural system is to be the result. There can be no serious consideration of a natural classification on the sole basis of vascular anatomy. It is essentially an auxiliary to taxonomy, but one that should not be neglected. The anatomical history of a group frequently discloses a new point of view regarding affinities which serves to improve our knowledge of the natural system. To construct any scheme based on all the characters known is of course the desired result.

To find the phyletic characters in this series I have, therefore, undertaken an investigation of all available material from the following families: [2]

[2] The arrangement of families is that of the writer, but the families are defined as they are in Engler and Prantl.

1. Dilleniaceæ.
2. Actinidiaceæ (including Saurauiaceæ).
3. Theaceæ.
4. Marcgraviaceæ.
5. Caryocaraceæ.
6. Guttiferæ (including Hypericaceæ).
7. Quiinaceæ.
8. Eucryphiaceæ.
9. Ochnaceæ.
10. Dipterocarpaceæ.
11. Flacourtiaceæ.
12. Cochlospermaceæ.
13. Bixaceæ.
14. Cistaceæ.
15. Canellaceæ.

If phylogenetic trends that meet the demands of taxonomy and anatomy can be identified in these groups, the relationship of the Hypericaceæ to the Guttiferæ can be established on a more definite basis.

The various phylogenetic arrangements of the angiosperms show the treatments of the groups under consideration at this time to be almost as numerous as the authors. In text fig. 1 are listed the phylogenetic trends of these groups as seen by the workers whose names head the various columns.

The above botanists have been selected because they have furnished the systems of classification that are best known at the present time. Certain other botanists have made notable contributions to the systems of plant classification. H. Hallier, in his taxonomic treatment of the angiosperms,(45, 46) treats the groups under consideration as follows: In the Guttales, which he derives through the Dilleniaceæ, he includes several phylogenetic trends that fall into four lines, all coming from the Ochnaceæ, which are considered the basic family of the order and the starting point of several other orders: 1, the Bicornes, including the present Actinidiaceæ and Saurauiaceæ; 2, the Myrtinæ, including the Caryocaraceæ; 3, the Passionales, including the Flacourtiaceæ as the basic family; 4, the main body of the Guttales, including the present Marcgraviaceæ, Theaceæ, Quiinaceæ, Eucryphiaceæ, Cistaceæ (questionable), and Guttiferæ. Parallel orders to the Guttales and of different origin, though themselves related, are the Columniferæ, including the present Bixaceæ and Cochlospermaceæ in the Tiliaceæ, also the Dipterocarpaceæ, and the Anonales including the Magnoliaceæ prior to the Canellaceæ. Wernham(125) separates the Parietales into Parietales A (Guttiferales) and Parietales B (Rosales). Hayata(47) retains the series Parietales in the sense

of Engler and Prantl. Rendle(94) follows in the main the system of Engler and Prantl, but breaks the large complex Parietales of Engler and Prantl into the orders Parietales and Guttiferales, stating that "although the order Guttiferales is closely related to the Parietales, it may be distinguished by its generally axial placentation." Johnson(62) retains the order Parietales of Engler and Prantl.

The presentation of these better-known works will suffice to show the perplexity of the situation. Which of these works approaches more nearly a natural classification? Will vascular anatomy be of aid in answering this question?

The writer takes great pleasure in expressing his deep obligation to Prof. R. H. Wetmore for generous assistance, guidance, supervision, and other expressions of personal interest in this problem.

MATERIALS AND METHODS

The material from the above families includes 120 genera and 537 species, plus numerous varieties and hybrids. Wherever possible, more than one slide has been examined. Several slides were examined when material of the species had been collected from various parts of the world. Each slide was examined with a description of its minute anatomy in mind.

Material collected in the field was killed and fixed, either in a solution of chromo-acetic acid or in formalin alcohol. Specimens from dried woods were made into blocks about 1 cm square, stamped with steel dies, and alternately boiled and drenched with cold water until they sank. Both types of materials were then softened in strong hydrofluoric acid, washed, and dehydrated. The softer materials were embedded in celloidin according to the method used by Jeffrey,(60, 61) Wetmore,(124) and others. All were placed in glycerin alcohol until sectioned. For this purpose a Jeffrey-Thomson sliding microtome was employed. The sections were stained with iron-alum hæmatoxylin and safranin.

Most of the Hypericaceæ of North and Central America were collected by the author. Numerous wood specimens were re-

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FOOTNOTES TO TAB. 1

[a] The system of Bentham and Hooker was elaborated when botanists were still imbued with the idea of fixity of species. The system was never intended to express a complete phylogenetic scheme of classification, still one cannot help but wonder how seriously they considered the fixity of species. Certainly they recognized general tendencies and likeness between groups. The system is included here because of its bearing upon the development of later systems of classification.

[b] The families listed in parenthesis are considered part of the preceding family.

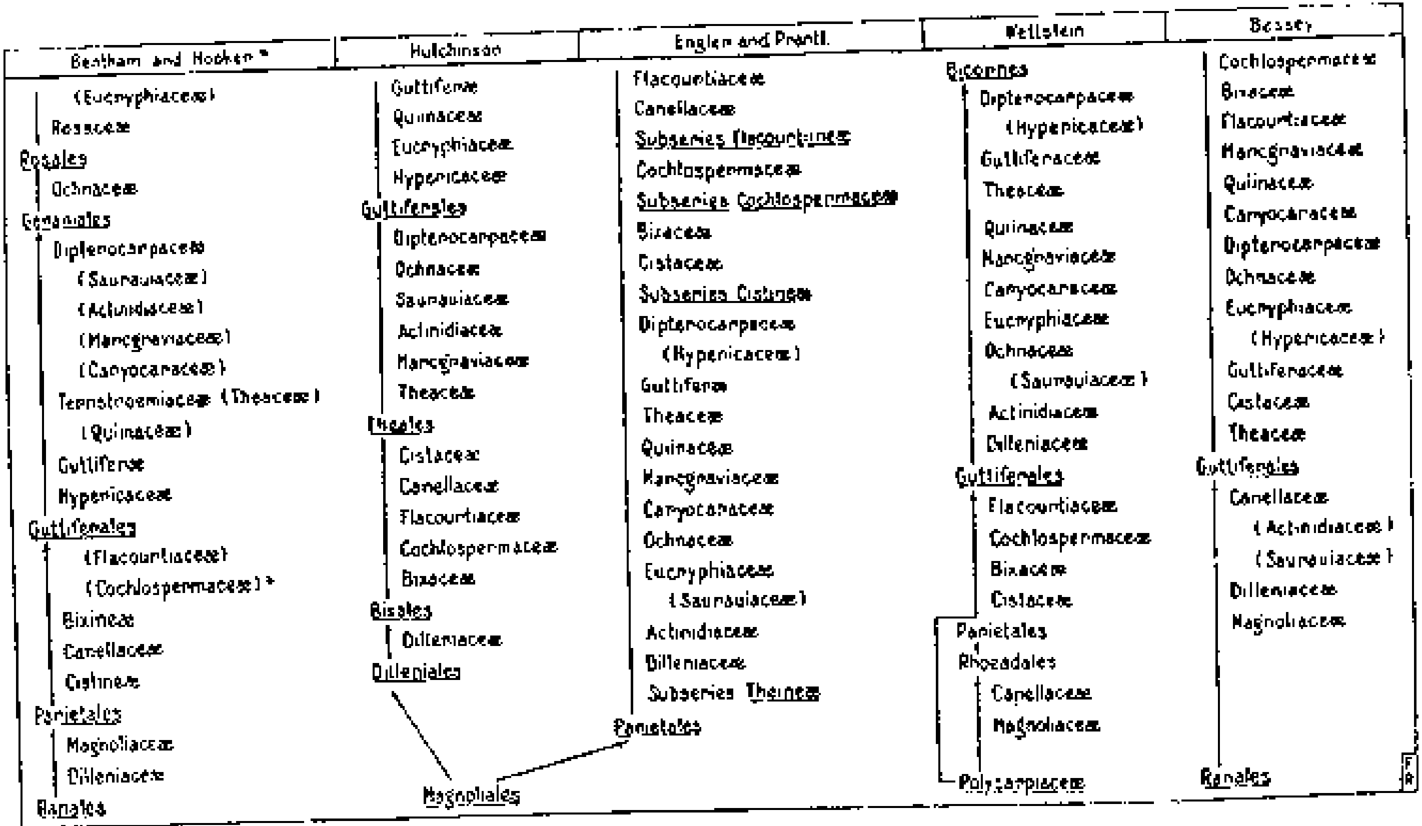

Fig. 1. Phylogenetic trends of angiosperms.

ceived from the world-wide collection of Prof. S. J. Record, School of Forestry, Yale University. Material was also received from the Kew Gardens, England; the Royal Botanical Garden, Edinburgh; the Station Agronomique de la Villa Thuret, Antibes; and the Arnold Arboretum of Harvard University.

The Magnoliales are not included in the present work, due to the recent paper of McLaughlin,(73) but his results were confirmed from the material available. The flacourtiaceous woods examined were those of Prof. W. W. Tupper, who recently published a preliminary work on this group.(116) Numerous slides of this and other groups were made available from the slide collections of Prof. I. W. Bailey and Prof. R. H. Wetmore.

Due acknowledgment is made of the coöperation and courtesy of these different institutions and individuals.

The classification used in the description of the minute anatomy is that of M. M. Chattaway.(20) This classification is the modified system of several earlier writers and was recommended for the consideration of the International Association of Wood Anatomists by a committee appointed by that body. Following this proposed classification, several papers have appeared on the value of measurements in wood anatomy, notably those of Desch,(28) Chalk and Chattaway,(17, 18) and Rendle and Clark,(97) all dealing with specific refinements in ways of measuring and presenting statistical data, for use in the identification of woods. However, the works of Prichard and Bailey(90) on *Carya ovata*, Clark(21) on *Ulmus*, and Bailey and Faull(4) on *Sequoia*, tend to show an even greater range of variability in different parts of a single mature tree than in homologous parts of different trees, with the elements showing a tendency to increase in size for several years, before reaching a more or less stable development. These facts have also been observed by the writer. Since from the available collections it has been impossible to ascertain from what part of a tree or shrub the wood was collected, cell size can be used only in a comparative sense. For this purpose the standards proposed by Chattaway seem adequate.

In the consideration of the general morphology, which accompanies each family, the author has taken freely from the taxonomic works of Wettstein,(127) Rendle,(91) Engler and Prantl,(32) Hutchinson,(59) and Johnson.(62)

The descriptive terms used in the minute anatomy are those suggested by the Committee on Nomenclature, International

Association of Wood Anatomists.(26) These terms are described in more detail and many of them illustrated by Record.(92) The ray types given with the descriptive anatomy are those proposed by Kribs.(70)

MORPHOLOGICAL AND ANATOMICAL DESCRIPTION OF FAMILIES

FAMILY DILLENIACEÆ

This family, as seen by E. Gilg and E. Werdermann in Engler and Prantl,(32) is composed of 11 genera and about 265 species. It is widely distributed in the tropical and subtropical regions, with the main center of distribution in Australia. *Hibbertia*, the largest genus (110 species), is almost exclusively Australian. The present study is based on the anatomical material of 8 genera, represented by 29 species.

Morphology.—Mostly trees or shrubs, very often lianas, seldom subshrubs or perennial herbs; leaves alternate, very seldom opposite, entire or dentate, rarely pinnatifid or trilobed, usually leatherlike with numerous prominent parallel lateral nerves; stipules absent or winglike and adnate to the petiole, mostly deciduous; flowers yellow or white to whitish, seldom red; flowers small to median-sized, rarely large, perfect, rarely polygamous or diœcious; sepals mostly 5, broadly imbricate, persistent and often enlarging; petals mostly 5, imbricate, often unequally wrinkled, deciduous; stamens numerous, rarely definite, hypogynous, free or variously united, usually persistent; anthers with lateral or introrse cells, opening lengthwise or by apical pores; carpels numerous, rarely 1, usually free; style usually free, as many as carpels, with a simple terminal stigma; carpels dehiscent or baccate; seeds mostly with a crested or laciniate aril; endosperm fleshy, copious; embryo straight, mostly minute.

Minute anatomy (Plate 1, figs. 1 to 4).—Pores diffuse, mostly solitary, occasionally in pairs, few to very numerous (50 ± in species of *Dillenia*, *Tetracera*, *Schumacheria*, and *Wormia*), mostly moderately few, very small to rather large, mostly moderate-sized, oval (Plate 1, fig. 1); vessel members long to extremely long, mostly very long; end wall highly oblique to slightly oblique, scalariform perforation predominant (porous only in the large vessel members of species in the "anomalous" genera *Davilla*, *Doliocarpus*, and *Tetracera*, but even in these the small vessels have scalariform perforations); bars on the end wall 6 to 130 ±, mostly completely bordered, occasionally bordered only at the end to the middle; intervascular pitting

predominantly opposite, scalariform (Plate 1, fig. 4) and transitional pitting common; vessel-ray pitting with half-bordered pit pairs; tyloses occurring in the end wall in several species of the genus *Dillenia* (Plate 1, fig. 3); rays multi- and uniseriate, heterogeneous, type I (except *Curatella* which is type II A), multiseriate rays very few or few (Plate 1, fig. 2), moderately broad to extremely broad, extremely low to very high (scleroid cells occur in the rays of *Davilla*); parenchyma mostly diffuse, occasionally with several paratracheal cells; fiber-tracheids nonseptate, all with bordered pit pairs (occasionally scalariform pitting in *Dillenia excelsa* Gilg), long, thin-walled occasionally thick (Plate 1, fig. 2), comprising the ground mass of the wood.

The spicular cells, mentioned by Solereder,(104) occurring in the pith of *Davilla, Doliocarpus,* and *Tetracera*, were observed. Stone cells were noted in the cortex of *Davilla, Doliocarpus, Tetracera*, and *Wormia*. No "anomalous" structure was seen in the species of *Doliocarpus* examined, although it has been reported and figured in this genus [Crüger 1850 (Solereder) in *D. Rolandri* Gmel., and later by H. Schenck 1893 (Solereder) in *D. scandens* (Aubl.) Gilg]. The tangential bands of parenchyma mentioned by Möller(80) as occurring in *Curatella americana* L. were not observed in any of the seven collections available.

In all main points, the above observations agree with those of Solereder,(103, 104) Hitzemann,(49) Möll and Janssonius,(79) Record,(91) and Pearson and Brown.(86)

FAMILY ACTINIDIACEÆ

This family as conceived by E. Gilg and E. Werdermann in Engler and Prantl(32) is composed of four subfamilies: I, Actinidiodeæ, with the single genus *Actinidia*, containing 23 species, all of eastern Asia; II, Saurauioideæ, with the single genus *Saurauia*, containing 250 ± species of tropical Asia and tropical America (1 species in northern Australia); III, Clematoclethroideæ, with the single genus *Clematoclethra*, having 10 to 12 species in eastern Tibet and middle China; IV, Sladenioideæ, with the single genus, *Sladenia*, with only 1 species of Burma and southern China. The two latter subfamilies are, as yet, not well known and are included in this family largely due to the work of S. Lechner.(71) In the present study they have been excluded, due mainly to lack of material. The pres-

ent study is based on the anatomy of *Actinidia* (3 species) and *Saurauia* (9 species).

Morphology.—Trees or often climbing shrubs; leaves always alternate, simple, dentate to grooved, glabrous to tomentose, mostly herbaceous, rarely more or less leatherlike, strong parallel nerves diverging from the midrib; stipules 0; flowering mostly in small, axillary dichasia but sometimes also in a paniclelike or many-flowered inflorescence, perfect, polygamous, or diœcious; sepals 5, imbricate, deciduous or persistent, some becoming enlarged and leathery; petals 5, imbricate, mostly membranaceous, free or variously united at the base; stamens ∞ to 10, free or coalescent with base of petal; anthers versatile, opening by short longitudinal split or terminal pore; ovary ∞ to 3 carpels, upright or united laterally, sometimes completely so; styles as many as the carpels, free or more or less united; ovules numerous in 2 series on axial placentation; fruit a berry or more or less regular capsule; seeds numerous or always 1 in each compartment; endosperm abundant, fleshy; embryo straight, one third to three fourths the length of the seeds; cotyledons short.

Minute anatomy (Plate 1, figs. 5 and 6).—Pores diffuse, mostly solitary or in pairs, occasionally in radial chains of 3 to 5, moderately few to numerous (30 ± in *Actinidia melanandra* Franch), very small to medium-sized, mostly small, round or slightly angular; growth rings observed in species of *Actinidia*; vessel members long to extremely long (mostly long in *Actinidia*, very long to extremely long in *Saurauia*); end wall mostly highly oblique, occasionally only slightly oblique, scalariform perforations predominant (Plate 1, fig. 5) (a few porous members in the liana types of *Actinidia*); bars on the end wall 15 to numerous, mostly bordered only at the end, some with slight borders complete; slight spiral thickening observed in species of *Actinidia*; intervascular pitting predominately opposite, scalariform and transitional pitting common (Plate 1, fig. 5); vessel-ray pitting with small borders; tyloses absent; rays uniseriate to multiseriate (4 to 6 cells wide), heterogenous type I, very few to moderately few, very fine to broad (depending on the seriation), very low to rather low, mostly low, very numerous sheath cells occurring in the multiseriate rays in most of the species of *Saurauia* (Plate 1, fig. 6); parenchyma mostly diffuse, pitting frequently unilaterally compound, paratracheal elements scattered in *Actinidia*, forming a 1-layered ring (vasi-

centric) in *Saurauia* (diffuse parenchyma very abundant in *Saurauia*); fiber tracheids nonseptate, all with bordered pit pairs usually in a single line on the sides of the element (Plate 1, figs. 5 and 6), thin-walled, mostly long, comprising the ground mass of the wood in *Actinidia*.

Solereder considers this group as a part of the Theaceæ (Ternstrœmiaceæ). All characters considered in his treatment fall in line with the observed results of Lechner.(71)

Certain characters separate these two subfamilies,[3] but in the main they vary but little from the previously described Dilleniaceæ.

FAMILY THEACEÆ [4]

In Engler and Prantl's(32) treatment of this group by H. Melchoir the family is composed of 23 genera with about 380 species of the tropical and subtropical regions of both hemispheres, with representatives in temperate eastern Asia. Fossil evidence tends to show this family as old and widely distributed. The present work considers the anatomical features as shown by 15 genera and 47 species.

Morphology.—Trees and shrubs; leaves alternate, simple, mostly evergreen; stipules 0; flowers perfect, rarely polygamous or diœcious, spirocyclic or cyclic, mostly solitary, rarely paniculate or racemose, often showy, actinomorphic, bracts often paired below the calyx; sepals 4, 5, 6, or 7, mostly 5, free or more or less united at the base, imbricate, persistent or deciduous; petals 5, seldom 4 or 4–9–∞, free or slightly connate, imbricate, seldom revolute; stamens numerous, seldom definite, arranged in many to one series, free or connate, sometimes adnate to the base of the petals; anthers 2-celled, opening lengthwise, very rarely by terminal pores; ovary superior, sessile, 2 to 10-locular, mostly 3 to 5; styles free or connate, as many as the ovary loculi; ovules 2 to ∞ in each cell, rarely 1, axile; fruit dehiscent or not, loculicidal or septicidal, often leaving a central column of seeds with usually scanty endosperm and straight or curved embryo variously folded or spirally twisted; cotyledons mostly flat, broader or of the same width as the hypocotyl.

[3] Hutchinson(59) treats these subfamilies as separate families, Saurauiaceæ and Actinidiaceæ.

[4] Theaceæ. The author follows the consideration of Engler and Prantl(32) in using this name. They in turn follow the discussion of this point by Sprague(107) and Fawcett and Rendle(34) in which the work of Sprague is accepted.

Minute anatomy (*Plate 2, figs. 7 to 12; Plate 3, fig. 13*).—Pores diffuse, solitary, in pairs, or occasionally in clusters, moderately few to very numerous, mostly numerous, extremely small to medium-sized, mostly small, oval to angular, growth rings observed in *Camellia*, *Eurya*, *Schima*, and *Stewartia*, and indistinct rings in *Anneslea* (Plate 2, fig. 7); vessel members short to extremely long, mostly long or very long; end walls highly oblique with scalariform perforations, 15 to 100 crossbars (Plate 2, figs. 9 and 10), bordered at the end or without a border (the tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ have slightly oblique end walls with porous perforations and alternate side-wall pitting) (Plate 2, figs. 8 and 12; Plate 3, fig. 13); spiral thickening on the vessel wall of some species; intervascular pitting dominantly transitional scalariform to opposite (Plate 2, fig. 10), except in the tribes noted above; vessel-ray pitting of half-bordered pit pairs, except in the tribe Bonnetieæ where the vessel-ray pitting is simple (Plate 2, fig. 8; Plate 3, fig. 13); tyloses present in the tribes Bonnetieæ and Tetrameristeæ (Plate 2, fig. 12); rays typically heterogeneous, dominantly type I with tendencies to types II and III in the tribe Ternstrœmieæ, dominantly type II A with occasional type II B and type III in certain genera in the tribe Camellieæ, typically type II in the tribe Bonnetieæ, type I in the tribe Tetrameristeæ, and homogeneous type III in the tribe Asteropeieæ, uniseriate, biseriate, triseriate, and multiseriate (4 to 6 cells wide), extremely fine to broad, mostly very fine to fine; multiseriate rays moderately numerous; uni- to triseriate, numerous to very numerous (5 to 15±); uniseriate rays with multiseriate rays few to numerous; extremely low to rather low, mostly extremely low; parenchyma paratracheal and diffuse, in some species of *Camellia* a tendency to metatracheal bands, 1 cell wide, pitting generally unilaterally compound or clusters (Plate 2, fig. 10), some simple; fiber tracheids nonseptate, all with bordered pit pairs usually in a single line (Plate 2, figs. 8 to 10; Plate 3, fig. 13), occasionally in several series, thin to thick, mostly thick, thick to very thick in the tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ (Plate 2, figs. 8, 11, and 12; Plate 3, fig. 13), short to very long, mostly long, parenchyma and ray cells containing druse crystals in the genera *Camellia*, *Gordonia*, and *Schima* of the tribe Camellieæ.

After eliminating the genera now considered in other families, the above work corresponds to that reported by K. Müller,(81)

Solereder,(103, 104) Hitzemann,(49) Möll and Janssonius,(79) Kanehira,(65–67) and Pearson and Brown.(86)

In their minute anatomy certain tribes (Bonnetieæ, Asteropeiceæ, and Tetrameristeæ) are not in harmony with the basic pattern exhibited by the rest of the group. On other grounds these tribes have been variously placed in other families, a consideration of which will be taken up in the discussion. The family in the main is rather homogenous as regards anatomical characters, exhibiting a primitive structure in the vessels and fibers, but advanced over the Dilleniaceæ.

FAMILY MARCGRAVIACEÆ

This small tropical American and West Indian family contains about 100 species in 5 genera, according to E. Gilg and E. Werdermann, in Engler and Prantl,(32) which are mostly climbing or epiphytic shrubs with pendulous terminal inflorescences.

The development of an upper bract above the two normal small bracteoles to form a colored nectarsecreting, generally hood- or pitcherlike structure, is of special interest in the family. This is most highly developed in *Marcgravia*, where the central flowers of the inflorescence are abortive and the highly colored bract which has become adnate to the flower stalk is converted into a stalked nectar-containing pitcher with an indication at the base of the small sterile flower (Rendle). The family was included by Bentham and Hooker as a tribe of the Theaceæ (Ternstrœmiaceæ), but because of its peculiar characters is now generally regarded as a separate family. The present study is based on the anatomy of only 4 species representing 3 genera.

Morphology.—Climbing and mostly epiphytic shrubs, rarely arborescent; leaves simple, alternate, sometimes dimorphic; stipules 0; flowers perfect, in terminal racemes or racemose umbels, the bracts of the sterile flowers variously modified into pitcherlike, saccate, or spurred bodies adnate to or free from the pedicel; sepals 4 or 5, free, imbricate; petals 4 or 5, united at the base or joined in a calyptrate deciduous mass; stamens ∞ to 3, free or slightly connate; anthers 2-celled, opening lengthwise; ovary superior, 3- or more-celled; stigmata sessile, radiate; ovules numerous in several rows on thick placentæ; fruit capsulelike, thick and fleshy, globose, indehiscent or slightly dehiscent into the cells at the base; seeds numerous, small, without endosperm; embryo slightly curved, with large hypocotyl and two small cotyledons.

Minute anatomy (*Plate 3, figs. 14 and 15*).—Pores diffuse, solitary to chains and clusters, moderately few to numerous (30 ±), small to large (300 ± in one specimen, *M. rectiflora* Tr. and Pl. 4907 R) oval; no growth rings observed; vessel members short to long [long to extremely long in *Norantea subsessilis* (Bth.) Denn. Smith]; end wall oblique-porous in *Marcgravia* (Plate 3, fig. 14), few-barred-scalariform to multiple in *Souroubea* (Plate 3, fig. 15), highly oblique-scalariform, with numerous bars bordered at the end, in *Norantea;* intervascular pitting opposite in *Norantea*, alternate to coalescent (hexagonal pit pairs) in *Souroubea*, and alternate to coalescent in *Marcgravia;* vessel-ray pitting composed of half-bordered pit pairs; rays heterogeneous type I (mostly upright cells in *Marcgravia* and *Souroubea*), uniseriate and multiseriate (3 to 6), very fine to broad, very low to moderately high, few to moderately numerous; druse crystals occasional in the ray cells of *Marcgravia*, general in *Norantea*, the cells often septate, globules (possibly oil globules) existing in the ray cells and to some extent in the fiber tracheids of *Marcgravia;* parenchyma paratracheal and diffuse, very limited; fiber tracheids thin-walled with bordered pit pairs, comprising the ground mass of the wood, nonseptate and spirally thickened in *Norantea*, septate in *Marcgravia* and *Souroubea*.

Anatomically this is a very heterogenous group, but the genus *Norantea* possesses characters that would seem to link this family very closely to the Theaceæ. Solereder,(104) following the classification of Bentham and Hooker, considers these genera as belonging to the Theaceæ. The author's findings in the anatomy of this group agree with those noted by Solereder.

FAMILY CARYOCARACEÆ

According to R. Pilger, in Engler and Prantl,(32) this family is made up of 2 genera, *Caryocar* with 15 species and *Anthodiscus* with 3 species. Both genera are found in tropical America. The present study is based on 5 species of *Caryocar* and 1 species of *Anthodiscus*.

Morphology.—Trees or shrubs; leaves opposite or alternate, digitately 3- to 5-foliolate; stipules absent; flowers perfect, in terminal ebracteate racemes; calyx 5- or 6-lobed, imbricate or truncate; petals 5 or 6, free or cohering above, imbricate; stamens numerous, subperigynous, in a ring at the base or in 5 bundles; filaments variously bent in bud, sometimes the inner ones without anthers; anthers small, 2-celled, opening length-

wise; ovary 4- or 8- to 20-celled; styles the same number, filiform; ovule solitary in each cell, ascending; fruit rather drupaceous with a woody endocarp breaking up into 1-seeded parts; seeds kidney-shaped with endosperm lacking or very thin; embryo with a large spirally twisted hypocotyl; cotyledons small, hooked-inflexed.

Minute anatomy (Plate 3, fig. 16).—Pores diffuse, solitary to chains and clusters (2 to 4), moderately few to numerous, medium-sized to rather large, mostly medium-sized, oval; vessel members long to very long (750 μ ±), mostly long; thin-walled tyloses observed in *C. villosum* (Aubl.) Pers.; end wall slightly oblique-porous, occasionally scalariform in *Anthodiscus;* intervascular pitting alternate, hexagonal in most cases; vessel-ray pitting simple or with slightly half-bordered pit pairs; parenchyma often with unilaterally compound pitting; rays heterogeneous type II A, uniseriate, biseriate, and occasionally triseriate (Plate 3, fig. 16), all the bi- and triseriate rays, with uniseriate extensions, extremely fine to very fine, extremely low to low, very numerous; parenchyma diffuse and slightly paratracheal; septate parenchyma and ray cells containing druse crystals (Plate 3, fig. 16)—frequent in all species of *Caryocar,* absent in *Anthodiscus;* fiber tracheids nonseptate, thick to very thick walls, with simple or very small bordered pit pairs.

The observations agree with those of Solereder,(103, 104) and Record,(91) although both of these authors place this group in the Theaceæ.

FAMILY GUTTIFERÆ

The Guttiferæ as listed by A. Engler and R. Keller, in Engler and Prantl,(32) consist of 46 genera and about 900 species. They are chiefly trees and shrubs, sometimes lianas, inhabiting the high-rainfall tropical areas of the world. The genus *Hypericum* alone is strongly developed outside of the Tropics, distributed in the temperate and mountainous regions of the earth, with great centers of distribution in the Mediterranean, eastern Asia, and eastern America. This genus contains about 200 species and includes all stages from perennial herbs with a persistent rhizome to undershrubs and shrubs. Many of the species have very wide ranges.

This family shows a remarkable diversity in the flower, especially in the number and arrangement of parts. Bracteoles are often developed close beneath the calyx, so that it is impossible to make a sharp distinction as to where the calyx begins; in

many cases this is also true between sepals and petals. A cruciform arrangement, where 2 pairs of sepals are followed by 2 pairs of petals and 2 pairs of stamens with the pistil forming a whorl of 4 carpels—pass through various stages to where a cruciform arrangement characterizes bracteoles and calyx, while petals and stamens are arranged spirally; or sepals, petals, and stamens are spirally arranged. In some cases the flowers are polygamous, as in *Mammea*. The andrœcium shows a great diversity; the stamens may be few, or with various degrees of union in filaments, rarely a cup, more frequently a lobed synandrium, or arranged as in *Hypericum*, in 3, 4, or 5 bundles. The stamens are generally opposite the petals. Staminodes occur variously united or are converted into secretory organs. The carpels are equal in number with the petals, or twice to three times as many, or united into a single whorl. The styles are free or partly united, sometimes very short; the stigmas generally broad.

Morphology.—Trees, shrubs, seldom lianas or herbs, with simple, entire-margined, opposite (rarely alternate or whorled) leaves, all with resinous juice or gland-dotted leaves with no stipules; inflorescence variously cymose; flowers actinomorphic, unisexual, polygamous or diœcious, perfect, sepals 2 to 6, rarely more, imbricate; petals the same number, hypogynous, contorted or imbricate, very rarely subvalvate; stamens mostly numerous, hypogynous, free or various connate in the lower part or into bundles, opposite the petals; anthers 2-celled, opening lengthwise; rudimentary ovary sometimes in the male flower when diœcious; staminodes often present; ovary sessile, superior, mostly 5 or 3, occasionally more (up to 15) or less (2 or 1); ovules 1 to many, on the inner angle or erect from the base of the cells, rarely parietal; stigmas various, sometimes radiating; styles free or partly united, often short; fruit of varied nature, often capsulelike, frequently a stone fruit or berrylike, sometimes large and globose; seeds often arillate, without endosperm; embryo with several different types of development of the hypocotyl in proportion to the cotyledons, frequently with weakly developed cotyledons, sometimes without such.

Anatomy (Plate 3, figs. 17 and 18; Plate 4, figs. 19 to 24; Plate 5, figs. 25 to 30; Plate 6, figs. 31 to 36).—Pores diffuse, solitary, pairs to chains or chains to clusters, occasionally solitary, few to very numerous, mostly moderately few to numerous; exceedingly small to rather large, mostly small to moderate-

sized (Plate 3, fig. 17; Plate 4, figs. 19 to 24), round or oval, mostly oval, growth rings observed in several species; vessel members very short to long, mostly short or long; end wall slightly oblique to transverse, porous [occasionally scalariform or clustered in tribes Clusieæ, Endodesmieæ, and Hypericeæ (Plate 6, figs. 35 and 36)]; intervascular pitting dominantly alternate [scalariform and coalescent in the tribe Clusieæ (Plate 3, fig. 18), frequently coalescent in the tribe Hypericeæ], pits generally large; tyloses quite frequent; vessel-ray pitting simple, or of slightly half-bordered pit pairs; rays uni- to multiseriate, typically uniseriate or uniseriate and multiseriate, heterogeneous, dominantly type I, but occasionally type II A in the tribe Clusieæ, type II A and B with certain genera showing type III in the subfamily Calophylloideæ, the other members of the family are typically type II B with type III dominant or occasional in certain genera (homogeneous type I in the genera *Allanblackia*, *Pentadesma*, and *Moronobea*), frequently all upright cells or upright cell conspicuous on the margins, uniseriates very fine, extremely low, very numerous; multiseriates fine to broad, extremely low or very low, occasionally rather low, moderately numerous to few (Plates 5 and 6, figs. 25 to 32); parenchyma paratracheal, or aliform to confluent, metatracheal, occasionally diffuse or absent (Hypericeæ) (Plate 4, figs. 19 to 24), parenchyma occasionally septate; fiber tracheids nonseptate (Plate 5, figs. 25 to 30; Plate 6, fig. 31), or septate (in most Hypericeæ and Clusieæ) (Plate 3, fig. 18: Plate 6, figs. 32 and 33), very short, wall very thin to very thick, mostly either thin or thick, pitting bordered or occasionally simple, generally numerous; tracheids surrounding the vessels in Hypericeæ and certain Moronobideæ which form a transition to the vessels; canals in the rays of certain Clusioideæ and Moronobideæ (Plate 5, fig. 27), secretory canals in the cortex frequent. Spiral thickenings were particularly noted in the South American species of *Hypericum* (section *Brathys*) (Plate 6, fig. 34). Nuclei were observed in fiber tracheids of *Hypericum* (Plate 6, figs. 32, 33, 35, and 36), occasionally found in division (Plate 6, fig. 33).

The family is of considerable economic importance. The wood of many species is hard and durable, and many yield valuable resins or gum resins, especially in *Calophyllum*, *Clusia*, and *Garcinia;* for example, gamboge from *Garcinia Morella*. Others yield edible fruits, such as the mangosteen, and mammee apple (*Mammea americana*). A fatty oil is obtained from the

seeds of *Calophyllum inophyllum*, *Garcinia indica*, and others; the thick sap of *Pentadesma butyraceum*, the West African "tallow-tree" is used as butter.

The present study is based on the anatomy of 29 genera and 238 species, representing all the tribes as conceived by A. Engler and R. Keller in Engler and Prantl.

As the name Guttiferæ suggests, the presence of intercellular, secretory receptacles (canals, or canals and cavities) is characteristic of the order. Secretory canals are present in the pith and in the primary cortex of the axis in almost all the members of the order; at the same time, they sometimes also occur in the primary and secondary bast, or in the secondary bast only. In the leaf the secretory canals either follow the vascular bundles in the veins or run independently of the vascular bundles in the mesophyll; in the latter case they are sometimes (*Calophyllum*) accompanied by peculiar bundles of tracheids and by sclerenchyma. In some genera the secretory canals of the leaf tissue are in part replaced by secretory cavities (Calophylloideæ and Hypericoideæ).

The above observations agree, in the main, with those of Müller,(81) Solereder,(103, 104) Turner,(117) Ursprung,(118) Möll and Janssonius,(79) Kanehira,(65–67) Jones,(63) Record,(91) and Pearson and Brown.(86)

FAMILY QUIINACEÆ

The Quiinaceæ as listed by A. Engler, in Engler and Prantl,(32) consists of 2 genera, *Quiina* with 16 species and *Touroulia* with 3 species. Both are found in tropical America, northern Brazil, Guiana, and eastern Peru. Only 3 species of *Quiina* were available for the present study.

Morphology.—Trees, shrubs, or climbers; leaves opposite or whorled, simple or pinnately lobed, lateral nerves numerous, tertiary nerves numerous, feather-veined; stipules paired, interpetiolar, rigid or foliaceous; flowers perfect or polygamous, paniculate or racemose; sepals 4 or 5, imbricate in pairs, small, unequal; petals 4 to 8, imbricate; stamens 15 to 30, free or nearly so; anthers 2-celled, opening lengthwise; ovary 2- or 3-celled or 7- to 11-celled; styles 2 or 3, free, linear, with 2 or 3 or 7 to 11 disclike stigmata; ovules paired, ascending; fruit a 1 to 3-seeded berry; seed tomentose; embryo straight; endosperm 0; cotyledons thickened and with a very small hypocotyl.

Minute anatomy (Plate 7, fig. 37).—Pores diffuse, solitary, paired, or occasionally in a chain (3 or 4), numerous, small;

vessel members short to very long, mostly long, oval; end wall slightly oblique, porous; intervascular pitting alternate to coalescent in contact with the ray parenchyma; vessel-ray pitting of half-bordered pit pairs; tyloses absent; rays heterogeneous type I, uniseriate, biseriate, and occasionally triseriate, very fine, extremely low to very low, very numerous; the bi- and triseriate rays with long uniseriate extensions (Plate 7, fig. 37); parenchyma diffuse; fiber tracheids nonseptate, very thick-walled, with numerous well-bordered pit pairs (Plate 7, fig. 37); septate parenchyma containing druse crystals, very rare, in *Quiina Cruegeriana* Gris. (4915 R.)

The Quiinaceæ, here regarded as a separate family, are essentially distinguished from the Guttiferæ by the absence of schizogenous resin canals, by the occurence of lysigenous mucilage canals, and possessing type I rays. In regard to their remaining anatomical features the Quiinaceæ fall within the circle of affinity of the Guttiferæ, as a branch of the Theaceæ.

FAMILY EUCRYPHIACEÆ

This family, as treated by E. Gilg, in Engler and Prantl,(32) is composed of the monotypic genus *Eucryphia* with its 4 species. The geographical range of the genus is Australia, Tasmania, and Chile. Three of the species form the basis of the present treatment.

Morphology.—Evergreen trees, leaves opposite, simple or pinnate; stipules small, coalescent; flowers perfect, axillary, solitary, actinomorphic, large, white; sepals 4, rigid, imbricate, cohering at the apex and somewhat calyptrately deciduous; petals 4, large, imbricate; stamens numerous in many series on a thin disc; filaments filiform; anthers small, orbicular; ovary 5- to 18-celled, sulcate, narrowed into 5 to 18 free, slender styles; ovules several, hanging in two series from the inner angle of the cells; fruit a leathery or woody capsule, 5- to 18-valved, valves boat-shaped, beaked by the persistent styles and separating from the axis; seeds pendulous, oblong, compressed, imbricate, winged; endosperm fleshy; cotyledons leafy; hypocotyl short.

Minute anatomy (Plate 7, figs. 38, 39, and 40).—Pores diffuse, solitary to chains and clusters, very numerous (100 to 200 per square mm) occupying a large portion of the transverse section (Plate 7, fig. 38), very small to small (50 μ ±); growth rings observed in all species; vessel members long to very long (750 μ ±), oval-angular; end wall highly oblique, scalariform (Plate 7, figs. 39 and 40), occasionally reticulate or porous,

usually with 20 ± bars, bordered only at the ends, slightly spiral thickening noted in two species, none in *E. cordifolia* Cav.; intervascular pitting transitional, scalariform to opposite (Plate 7, figs. 39 and 40); vessel-ray pitting simple to half-bordered pit pairs; tyloses absent; rays uniseriate, biseriate, and occasionally triseriate, heterogenous types II B and III (approaching Homo III in *E. Billardieri* Spach., the Tasmanian species), very numerous, very fine to fine, extremely low to very low, all ray cells containing a dark-brown-stained substance; parenchyma mainly diffuse, becoming metatracheal or terminal near the growth rings (Plate 7, fig. 38); fiber tracheids nonseptate, thick walls with bordered pit pairs in single rows on the sides of the elements (Plate 7, figs. 39 and 40).

The genus is a very homogeneous one, with a rather primitive array of characters, except in ray type. The above description is in agreement with that of Record.(91)

FAMILY OCHNACEÆ

This family, as seen by E. Gilg in Engler and Prantl,(32) is composed of 20 genera containing about 370 species distributed in the Tropics of the world, especially in Brazil. The family is divided into 2 large tribes, the Exalbuminosæ and the Albuminosæ, on the basis of absence or presence of endosperm in the seed. The present study is based on 8 genera and 26 species, of which 5 genera and 21 species are found in the tribe Exalbuminosæ.

Morphology.—Trees or shrubs with watery juice, rarely herbs; leaves alternate, simple, very rarely pinnate, often with numerous pinnate nerves; stipules present, sometimes laciniate; flowers perfect, actinomorphic or occasionally more or less zygomorphic, mostly racemose or paniculate; sepals mostly 5, rarely 10, free, imbricate or rarely contorted; petals free, 5 to 10, subsessile, contorted or imbricate; stamens few to many, free, staminodes sometimes present, subulate or petaloid, sometimes connate into a tube; filaments persistent; anthers linear, basifixed, opening lengthwise or by a terminal pore; ovary entire to deeply lobed, 1- to 10-celled; ovules 1 to ∞, axial or parietal or attached to the intrusive placentæ; style simple or split at the apex; fruiting carpels often becoming quite separate on the enlarged torus, and drupaceous, or elongate, capsular, and septicidal; seeds 1 to many, with or without endosperm; embryo usually straight.

Minute anatomy (Plate 7, figs. 41 and 42; Plate 8, figs. 43 to 45).—Pores diffuse, mostly solitary or in pairs, occasionally in

radial chains or clusters, few to very numerous, mostly moderately numerous to numerous, very small to moderate-sized, round to oval (Plate 7, figs. 41 and 42); growth rings in a few species; vessel members very short to long, mostly short; end wall obliqueporous; intervascular pitting alternate, pits dominantly very small and numerous; tyloses rare; vessel-ray pitting simple or of slightly half-bordered pit pairs; rays uniseriate to multiseriate (4 to 6 cells wide) heterogenous, typically type I in the subfamily Albuminosæ, dominantly type I in the Exalbuminoseæ but closely approaching type II A, homogeneous type II in *Lophira*, uniseriate, very fine to occasionally fine, numerous to very numerous, extremely low to very low; multiseriate, mostly moderately broad, occasionally broad, few to numerous, low to moderately high (Plate 8, figs. 44 and 45); parenchyma paratracheal, metatracheal, and diffuse, metatracheal most common in the genus *Lophira* (5 or 6 cells wide) (Plate 7, fig. 42; Plate 8, fig. 43); crystals occasional in most genera, either in the ray parenchyma or longitudinal parenchyma, parenchyma containing these crystals frequently septate; fiber tracheids nonseptate or septate, thin to very thick, mostly thick to very thick, mostly long, pit pairs simple or slightly bordered, generally numerous.

A common anatomical character is the presence of leaf-trace bundles in the cortex (Rendle). Douliot (Solereder) also gives cortical bundles as a common character of the Dipterocarpaceæ. The two subfamilies, Exalbuminosæ and Albuminosæ, as the names imply, are separated on the basis of the presence or absence of endosperm. Anatomically they can be separated by the presence of vestured pits in the Exalbuminosæ, lacking in the Albuminosæ (Bailey).(3) In the members of the Albuminosæ the upright ray cells are much more elongate, making the ray more heterogeneous than in the Exalbuminosæ. Also, septate fiber tracheids are present in certain of the Albuminosæ, and completely absent in the Exalbuminosæ.

The genus *Lophira* is included in the Dipterocarpaceæ by Bentham and Hooker, but placed in the Ochnaceæ by Gilg. According to Van Tieghem(112) it differs in lacking resin canals and in the stratification of the bast, which is peculiar to the Dipterocarpaceæ. Rendle states: "In *Lophira*, a monotypic genus of tropical Africa, the two outer sepals become much elongated in the fruit forming a wing which ensures distribution (compare Dipterocarpaceæ)." Anatomically *Lophira* possesses metatracheal parenchyma and vestured pits, also characteristic of the Dipterocarpaceæ. It seems quite possible that the Exalbuminosæ

of the Ochnaceæ connect with the Dipterocarpaceæ through the genus *Lophira*.

FAMILY DIPTEROCARPACEÆ

The Dipterocarpaceæ, as presented by E. Gilg in Engler and Prantl,(32) consist of 19 genera in 2 subfamilies containing over 350 species of trees, rarely shrubs, inhabiting the tropical forest of India, the Malay Peninsula, the East Indian Islands, and tropical Africa. Its members produce many valuable timbers, and many yield important oils, resins, and copal. The present study is based on woods representing 8 genera and 60 species.

Morphology.—Trees, rarely shrubs, with resinous wood; leaves alternate, simple; indumentum of stellate hairs or of peltate scales; stipules small or large, deciduous; flowers perfect, actinomorphic, fragrant, in axillary panicles; bracts usually absent; calyx tube short or long, free or adnate to the ovary; lobes 5, imbricate or valvate, usually enlarged and winglike in fruit; petals 5, much twisted, free or slightly connate, often hairy; stamens 5, 10, 15, or more, in 1 or more cycles, hypogynous or subperigynous; anthers 2-celled, opening lengthwise; ovary 3-celled; style entire or 3-lobed; ovules 2 in each cell, pendulous or lateral, anatropous; fruit indehiscent, mostly 1-seeded; seeds without endosperm; cotyledons often twisted, inclosing the hypocotyl.

Minute anatomy (Plate 8, figs. 46 and 47).—Pores diffuse, mostly solitary or in pairs, occasionally in short chains or clusters, mostly few or moderately few, occasionally moderately numerous to numerous, medium-sized to rather large, occasionally small, oval (Plate 8, fig. 46); vessel members short, occasionally very short or long; end wall porous; tyloses frequent; intervascular pitting alternate, with a few coalescent pits in some species, vestured pitting frequent; vessel-ray pitting simple, rarely bordered; rays uni- to multiseriate (3 to 6 cells wide), heterogeneous type II B; uniseriate rays very numerous, extremely fine to very fine, extremely low to very low; multiseriate rays moderately numerous, fine to moderately broad; occasionally septate ray cells containing crystals; parenchyma diffuse, aliform to confluent and in other cases definitely metatracheal, occasionally septate parenchyma with crystals, resin canals occurring in bands or groups of parenchyma (Plate 8, fig. 46); fiber tracheids nonseptate, mostly with slightly bordered pit pairs, or simple, short to long, thick to very thick or occasionally thin-walled, usually in bands alternating with parenchyma.

Bailey[3] records the presence of vestured pits in this family, and these were observed by the author in several of the genera. Douliot (Solereder) mentions as a common character of the Dipterocarpaceæ the presence of cortical bundles. Guerin (Solereder) states that the resin canals in this order are schizogenous in origin, and arise between four cells of the cambium. The presence of these resin canals in the secondary xylem and elsewhere has been used by several authors (Rendle, Engler and Prantl, and others) as indicating relationship with the Guttiferæ.

The above work is in agreement with that of Müller,[81] Solereder,[103, 104] Hitzemann,[49] Möll and Janssonius,[79] Foxworthy,[36, 73] Reyes,[99] Pearson and Brown,[86] and Bailey.[3]

FAMILY FLACOURTIACEÆ

According to E. Gilg, in Engler and Prantl,[32] this family includes 84 genera and about 800 species of woody plants, often forming large trees with a wide distribution in the Tropics. It includes the Samydaceæ and a part of the Bixaceæ of earlier classifications and is divided into 11 tribes. The present study is based on the secondary anatomy of 32 genera and 90 species, representing 6 tribes.

Morphology.—Trees or shrubs; leaves simple, alternate, generally thick, leathery and evergreen; stipules often soon falling off; flowers perfect, monœcious or diœcious, rarely polygamous, generally small and arranged in lateral or terminal cymes, but in *Oncoba* often very large and generally axillary, regular, structure varied, generally cyclic but sometimes spirocyclic; sepals 2 to 15, sometimes not distinguished from the petals, imbricate or open in bud, sometimes united below to form a short tube, which is united with the ovary, the ovary becoming half inferior (inferior in *Bembicia*); petals sometimes not arranged regularly in relation to the sepals, large, small or absent, with or without an opposite scale inside the base, imbricate; stamens numerous, rarely few, in one or two whorls or apparently irregularly arranged, hypogynous, free; anthers 2-celled, often short, opening lengthwise by slits, ovary 1-celled of 2 to 10 united carpels with 1 or more parietal placentæ or rarely the placentæ meeting in the middle; ovules 2 or more on each placenta; styles or stigmas as many as the placentæ; fruit indehiscent, mostly a berry or drupe, very rarely a capsule, sometimes large; seeds with fleshy endosperm and medium-sized embryo; cotyledons often broad.

Minute anatomy.—Pores diffuse, mostly solitary or in pairs, occasionally in short chains or clusters, moderately few to very

numerous, mostly numerous, very small to moderate-sized, mostly small, oval; vessel members short or long, occasionally very short or very long; end wall typically porous, although scalariform perforation plates occur in several genera of the tribes Oncobeæ and Pangieæ, but even here simple perforations are the rule and may occur side by side with the scalariform type; tyloses occasionally, intervascular pitting typically alternate, but here again in the tribes Oncobeæ and Pangieæ transitional pitting is the rule; vessel-ray pitting generally of slightly half-bordered pit pairs; rays uni- to multiseriate (3 to 5, occasionally to 10 cells in width) heterogeneous, type I in the tribe Oncobeæ, type I with a greater tendency to type II in the tribes Pangieæ and Homalieæ, both types I and II A in the tribes Scolopieæ and Casearieæ, and types II A and B in the tribe Flacourtieæ; uniseriate rays, numerous, fine, very low to low, occasionally extremely low; multiseriate rays few to moderately numerous, very low or rather low, typically with vertically elongate uniseriate extensions, occasional crystals in the ray cells; parenchyma typically absent, when present very scanty and paratracheal; fiber tracheids generally septate, very thin or thin-walled with slightly bordered or simple pit pairs, short to long; in fiber tracheids with a thick wall a definite concentric pattern in the wall is seen in cross section. These elements comprise in most cases the ground mass of the wood.

This family is capable of being grouped into tribes that are obviously related but possess tendencies leading in several directions from the more primitive tribes. This is quite apparent from the study of the vessel members and the ray types. The tribes agree very closely with the phylogenetic relationships proposed by Engler and Prantl.(32) The most constant characters in the secondary xylem are the generally septate fiber tracheids, which in the thick-walled types studied are concentric, and the absence or scanty development of the parenchyma.

The findings in this group, early considered in the Bixineæ, agree in most essential details with those reported by Solereder,(103, 104) Turner,(117) Möll and Janssonius,(79) Kanehira,(65) Record,(91) and Tupper.(116)

FAMILY COCHLOSPERMACEÆ

R. Pilger, in Engler and Prantl,(32) considers this family as composed of 3 genera containing 23 species, *Cochlospermum* with 15 species in the Tropics of the Old and New Worlds;

Amoreuxia with 6 species in Central America, and *Sphærosepalum* with 2 species in Madagascar. The present work is based on the single species *Cochlospermum vitifolium* (Willd.) Spreng. of Mexico and northern South America.

Morphology.—Trees, shrubs, or rhizomatous subshrubs with colored juice; leaves alternate, palmately lobed, stipulate; flowers perfect, paniculate or racemose; sepals 5, imbricate, deciduous, petals 5, imbricate or subcontorted; stamens numerous; filaments free, but many vary in height; anthers 2-celled, linear, opening by terminal, often confluent, porelike slits; ovary 1-celled with parietal placentæ or perfectly 3-celled; ovules numerous; style simple with small denticulate stigma; fruit a 3- to 5-valved capsule; seeds glabrous or hairy, straight or reniform; endosperm copious; embryo conforming to the shape of the seed, large; cotyledons broad.

Minute anatomy (Plate 8, fig. 48).—Pores diffuse, solitary, in pairs, occasionally in chains of 3 or 4, moderately numerous (15±), medium-sized; growth rings not seen; vessel members long, slightly oblique with porous end wall; no spiral thickening; intervascular pitting alternate, pits numerous and crowded (Plate 8, fig. 48); vessel-ray pitting simple to half-bordered; tyloses absent; rays uniseriate to multiseriate (1- to 4-seriate), heterogeneous type II B, upright cells rather square, fine to moderately broad, very low to low, very numerous, some of the larger rays containing ducts; parenchyma paratracheal, 1 or 2 cells wide, usually connecting with the metatracheal bands which are 5 to 8 cells wide and very conspicuous; fiber tracheids very short, very thin-walled, with quite numerous, small, bordered pit pairs. The fiber tracheids and metatracheal parenchyma comprise the ground mass of the wood (Plate 8, fig. 48).

FAMILY BIXACEÆ

This small monotypic family is composed of the genus *Bixa* with 2 species, *B. Orellana* L. and *B. arborea* Huber, according to R. Pilger, in Engler and Prantl.(32) The outstanding species, *B. Orellana* L., is a tree native of tropical America but cultivated throughout the world for the red annatto or orleans dye, which is made from its fleshy seed coat. *Bixa arborea* Huber is a tree of the Amazon region. The present work includes both species.

Morphology.—Shrubs or small trees with colored juice; leaves alternate, simple palminerved, stipulate; flowers perfect,

medium-sized, showy, paniculate; sepals 5, imbricate, deciduous; petals 5, large, imbricate, without a scale at the base; stamens numerous, hypogynous; filaments free, anthers horseshoe-shaped, opening by short slits at the top; ovary superior, 1-celled, with 2 parietal placentæ; ovules numerous; style slender, recurved in bud; stigma 2-lobed; fruit a densely echinate-setose or smooth capsule, 2-valved, valves thick with the placentæ in the middle; seeds obovoid; testa rather fleshy, red; endosperm copious; embryo large; cotyledons broad, incurved at the apex. Characteristic of the Bixaceæ is the anther form and the formation of the seed coat.

Minute anatomy (*Plate 9, figs. 49 and 50*).—Pores diffuse, chains to clusters, oval, numerous to very numerous (80 ±) (Plate 9, fig. 49); vessel members small to medium-sized (100 ±), short; end wall slightly oblique to transverse, porous; intervascular pitting alternate, pits very small and crowded; vessel-ray contact with half-bordered pit pairs; rays uni- and biseriate, occasionally triseriate, heterogeneous type II B; very fine, extremely low to very low, very numerous, appearing storied in tangential section (Plate 9, fig. 50); parenchyma mostly diffuse, composed of wood parenchyma strands of 4 cells, occasionally paratracheal, thin-walled; fiber tracheids non-septate, very thin, bordered pit-pairs quite small, not numerous. The fiber tracheids form the ground work of the wood.

FAMILY CISTACEÆ

The Cistaceæ as defined by E. Janchen in Engler and Prantl,(32) consist of 8 genera and 170 species of herbs or shrubs, with the Mediterranean region as the large center of distribution but with certain genera along the Atlantic coast of North America to the West Indies. The present study is based on the minute anatomy of 4 genera and 7 species.

Morphology.—Herbs or shrubs, often with stellate indumentum; leaves opposite, rarely alternate, simple; stipules present or adnate to the petiole; flowers perfect, actinomorphic, solitary to cymose, showly; sepals 3 to 5, contorted; petals 5 to 0, contorted, early deciduous; stamens numerous, hypogynous; filaments free; anthers 2-celled, introrse, opening lengthwise; ovary superior, 1-celled with parietal placentæ or incompletely septate towards the base; ovules 2 or more to each placenta; style simple with 3 to 5 free or united stigmas; fruit a capsule opening by valves from the top downward; seeds with endosperm and having a bent, coiled, or folded embryo.

Minute anatomy (*Plate 9, fig. 51*).—Pores diffuse, solitary, very numerous, very small, round to slightly oval; vessel members very short; end wall slightly oblique, porous, occasionally 1 to 3 simple perforations at one end; tyloses rare; intervascular pitting alternate, few or quite numerous, very small; vessel-ray pitting of slightly half-bordered pit pairs; growth rings in a few cases; rays in *Cistus* and *Lechea* (in part) 1- to 3-seriate, heterogeneous types II B and III, usually upright cells, extremely fine to very fine, extremely low, very numerous (Plate 9, fig. 51); rays in *Helianthemum*, *Hudsonia*, and *Lechea* (in part) uniseriate, heterogeneous type III; 1 to 3 cells tall, vertically elongate, very irregular in shape, and inconspicuous, parenchyma absent; fiber tracheids thin-walled, very short, nonseptate, with slightly bordered pit pairs (Plate 9, fig. 51).

Solereder(104) in quoting Piccioli's investigations, states: "In the wood, medullary rays are not present in *Lechea*, whilst in the remaining genera they are narrow and mostly uniseriate. As a rule the bulk of the wood is composed of prosenchyma with bordered pits; in the species of *Helianthemum* belonging to the section *Eriocarpum* however, the tracheids are replaced by mechanical elements. Wood-parenchyma only occurs in relatively small amounts."

As has been noted above, the writer observed ray cells in all genera and species, although *Helianthemum*, *Hudsonia*, and *Lechea* (in part) showed only uniseriate rays, 1 to 3 cells tall, vertically elongate, and irregular in shape. Except that these cells are arranged in a radial manner, they might easily have been mistaken for longitudinal parenchyma. However, there can be no doubt that these radial seriations of cells are rays.

Turner(117) considers this group as nearly related to the Hypericaceæ, and that both groups show a relationship to the Flacourtiaceæ and Bixaceæ ("Bixaceen").

FAMILY CANELLACEÆ

E. Gilg's account of this family in Engler and Prantl(82) shows it to include 4 genera and 8 species, each genus limited in distribution. *Canella* (2 species) is found in the West Indies, southern Florida, and Columbia; *Cinnamosa* (2 species) in Madagascar; *Warburgia* (3 species) in East Africa; and *Pleodendron* (1 species) in Porto Rico. The present work is based on several collections of a single species in each of the first 3 genera mentioned.

Morphology.—Trees, seldom shrubs, leaves alternate, simple, glabrous, aromatic, gland-dotted; stipules absent; flowers perfect, actinomorphic, cymose; bracts 3, imbricate, persistent; sepals 4 or 5, free, thick, imbricate; petals thin, imbricate or absent; stamens hypogynous, up to 20; filaments connate into a tube with the anthers adnate to its outer side, opening lengthwise by valves; ovary superior, 1-celled; placentæ 2 to 6, parietal; ovules 2 to ∞ ; style thick; stigmas 2 to 6; ovules subanatropous; fruit a berry; seeds 2 or more, shining; endosperm oily and fleshy; embryo straight.

Minute anatomy (Plate 9, figs. 52 to 54).—Pores diffuse, solitary or in pairs (Plate 9, fig. 52), rarely clusters; moderately numerous to very numerous (*Capsicodendron*), small, occasionally very small (*Capsicodendron*); growth rings not observed, vessel members long to occasionally extremely long, mostly very long; end wall highly oblique, scalariform perforate, crossbars 12 to 60, completely bordered or bordered at the end to middle; intervascular pitting transitional to opposite, pits few; vessel-ray pitting of half-bordered pit pairs; tyloses absent; rays uniseriate, occasionally by- or triseriate, homogeneous types I and III (Plate 9, figs. 53 and 54), very fine, extremely low to very low, very numerous (10 to 15 ±), unilateral compound pitting present; druse crystals in the rays (Plate 9, fig. 54) (except *Capsicodendron*); parenchyma paratracheal (2 to 4 cells wide on one side of the vessel) (Plate 9, fig. 52), occasionally also diffuse; fiber tracheids nonseptate, thin or thick; pit pairs well bordered and large. The fiber tracheids form the ground mass of the wood in all but *Capsicodendron*, in which the parenchyma is conspicuous.

DISCUSSION

I. GENERAL

If we are to use comparative morphology in the interpretation of trends in the angiosperms, as has been done by the authors of the numerous systems, we must first understand the dicta upon which these classifications have been founded. In the present treatment we accept, as a working hypothesis, that the floral morphology of a majority of the dicotyledons may be traced back to a primitive ancestor, possibly "Ranalian." With this hypothesis as a basis, following the works of Bessey,(7-9) Wernham,(125) Hallier,(45) Arber and Parkin,(1) Sprague,(106) and Hutchinson,(59) we assume that: The bisexual preceded the

unisexual flower; spirally imbricate floral parts are more primitive than the whorled or valvate; the polymerous flower precedes and the oligomerous follows; polypetaly is more primitive than gamopetaly; actinomorphy of the flower precedes zygomorphy; hypogyny gives rise to perigyny and epigyny; apocarpy is more primitive than the connate resultant; polycarpy precedes oligocarpy; free styles precede connate styles; the endospermic seed with small embryo is primitive and the nonendospermic derived; many stamens are more primitive than few stamens; separate stamens precede connate stamens; the presence of stipules is more primitive than the absence of stipules; and trees preceded shrubs and herbs. We believe with Sprague[108] that a natural classification should be based on the synthetic method; that is, the adding of group to group according to the agreement between the sum total of their characters, and that the greater the number of common characters the closer the affinity, though tendencies should not be disregarded.

In the interpretation of the minute anatomy for purposes of classification of the angiosperms certain well-recognized principles have been established by several workers—Solereder,[104] Jeffrey,[60] Bailey and Tupper,[5] Frost,[38-43] and Kribs.[70] A summary of these principles follows:

(*a*) *Vessels*.—Frost, following and enlarging the work of Brown[13] and Thompson,[112] argues that the vessel member is phylogenetically related to and derived from the tracheid, and finds by correlation that long members having scalariform perforations with numerous bars, completely bordered on a highly inclined end wall, and with scalariform lateral pitting, are primitive. Similarly the most highly evolved vessel members are short with transverse porous perforations and with alternate side-wall pitting. All other types of vessel members are considered to be transitions in various degrees of specialization. A bordered pit in contact with a simple pit of parenchyma is considered more primitive than a simple pit pair. The distribution of vessels is a variable character. Spiral thickening would seem to have little value in the broader complexes. This is also true of tyloses.

(*b*) *Xylem parenchyma*.—The scanty or abundant occurrence of wood parenchyma is of considerable significance. The presence of septate-parenchyma containing crystals in the wood is generally only of specific value. The diffuse arrangement is considered more primitive than aggregates of parenchyma.

(c) *Rays.*—Bailey,[2] Myer,[82] DeSmidt,[30] and Weinstein[124] find the number of rays in similar annular rings of different individuals of the same species, and even within the same tree, is subject to great variation. This is particularly true of the multiseriate rays, which are found to be more numerous in the root and lower part of the stem than in the upper part of the stem; and to be more numerous in branches, especially on the lower side, than in the trunk. The number of uniseriate rays remains more nearly constant. Thus the number or volume of the rays, especially the multiseriate rays, cannot generally be considered of great diagnostic value.

Kribs[70] from observations of a large number of dicotyledonous woods finds certain salient lines of structural specialization in the wood rays. Based on a high correlation between vessel type and ray type, he segregates the rays into six classes or types. The homogeneous rays are considered more highly specialized than the heterogeneous rays. The primitive heterogenous condition is with the "uniseriate rays usually high, numerous and composed of very large, vertically elongated cells which are unlike the cells of the multiseriate part of the multiseriate" and with "multiseriate rays usually with parallel sides and with very large, vertically elongated, uniseriate wings (long wings) which are composed of cells identical with those of the uniseriate rays; the cells of the multiseriate portion of the rays are oval, radially elongated or vertically elongated." By a shortening of the extensions and the uniseriates, and by the elimination of the multiseriates, the other types of heterogeneous rays are derived. From these types the homogenous types are derived. Kribs, in his discussion, states that "the uniseriate rays occur as an offshoot in practically every type of woody dicotyledonous stem, indicating that it is a specialized structure due to the elimination of multiseriate rays." Since the primitive ray type in living dicotyledonous woods contains both uniseriate and multiseriate rays, when the multiseriates are eliminated, a more specialized wood is the result, and not necessarily a more specialized ray, as the cell type in the ray may remain the same. A similar result is obtained when the uniseriates are eliminated, leaving the multiseriates. It was found, in using the classification proposed by Kribs, that the specialization cells composing the uniseriate rays were a much better indicator of the type than the cells of the multiseriate ray; that is, the uniseriate rays are much more constant in

type within a group or a single specimen than are the multiseriate rays.

(*d*) *Tracheids, fiber tracheids, and fibers.*—The phylogenetic series is considered to have been in the order just indicated; namely, tracheids, fiber tracheids, and fibers. The tracheid is an imperforate, thin-walled cell with the pits to congeneric elements bordered. The fiber tracheid is commonly thick-walled, with small lumen, pointed ends, and with small bordered pits having lenticular to slitlike apertures. The fiber is similar to the preceding but with simple pits. Although the distinction between fibers and fiber tracheids is simple in itself, the maintenance of this distinction, which is very important, becomes very difficult, when the borders of the pits are very small. A simple slit-shaped pit occasionally appears to have a slight border when seen in surface view. The transverse section of the pit can alone decide whether the pit is really bordered or not. The presence of septate fiber tracheids is quite characteristic of large groups and thus may be of value. Solereder(104) and Frost(38) find a high correlation between scalariform-pitted lateral walls of vessel members and fiber tracheids.

II. FAMILIES

Hypericaceæ.—The genus *Hypericum*, the largest in the Hypericaceæ, contains, according to R. Keller in Engler and Prantl, about 300 species of shrubs and herbs, widely distributed, but with four main centers of distribution: (*a*) The Mediterranean complex, including all of Europe, the islands of the Middle Atlantic, northern Africa, and Asia Minor; (*b*) the African continent, and equatorial and South Africa; (*c*) eastern and southeastern Asia (Japan included), the Himalayan region, islands of the Indian Ocean, and Australia; (*d*) both American Continents. The species of any of these regions segregate very clearly into well-marked sections.

This genus displays in its floral morphology an extremely wide variation as to the number, distribution, and fusion of stamens, the number and fusion of styles and carpels, and the types of placentation. A part of this range of variation can be seen in text fig. 2.

Other characters, which have proven significant in the taxonomy of this genus, are: (*a*) The type of inflorescence, which is basically cymose; (*b*) the placentation, which, though generally axile, may become parietal; (*c*) a wide range of seed

characters [Keller, in Engler and Prantl,(32) Stefanoff(110, 111)].

The secretory organs, which are characteristically present in this group, are schizogenous in origin, as shown by Weill,(123) Kienast,(69) and others. They may be either secretory sacs or canals. The sacs are found in the leaves of all species in the genus, as well as in all other members of this family. The secretory canals in this genus are located principally in the pericycle

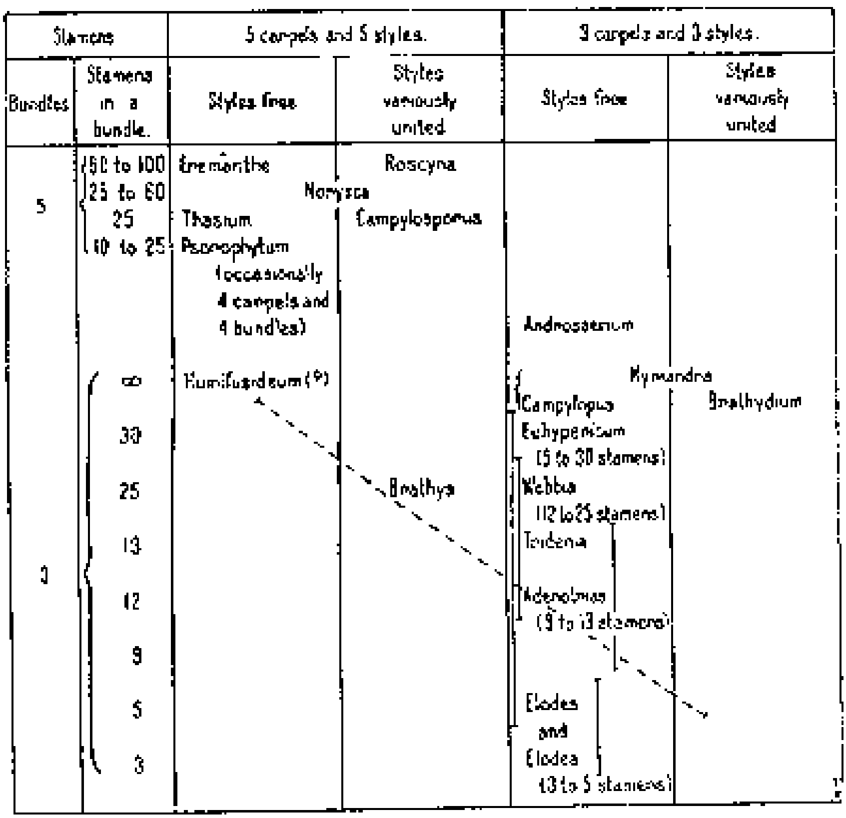

FIG. 2. Variations in the genus *Hypericum*.

and phloëm of the root and stem, but frequently are found in the leaves and flowers. In a few cases the canals are cortical or medullary. On approaching a node they usually divide once to several times. Clos(25) proposed a key to the genus based on the type and distribution of these secretory organs. The content of the sacs and canals in the genus is an oil containing a pigment. Microchemical tests indicate that the pigment is an

anthocyanidin, probably in part a rhamnose glucoside of pelargonidin [Siersch(100)]. The plants possess a toxic principle that has made certain species obnoxious weeds in cattle and sheep country [Marsh and Clawson,(74) and others].

The cytological behavior within the genus is not too well known. The numbers of chromosomes reported by Chataway,(19) Tischler,(115) Hoar,(50) and Hoar and Haertl(51) were: 7–8–9–10–12–16–19–20, with comparatively few of the species examined. Nielsen(83) does not believe that this represents an arithmetical series as proposed by Winge. However, he makes no statement as to an interpretation of these chromosome numbers. Wanscher,(122) in a statistical study of chromosomes from many families of plants, considers that the chromosome numbers in higher plants originate from a number belonging to a 4-system; that is, with other numbers either way in an ascending or descending series. In the genus *Hypericum* he regards the number 8 as the probable basic number, with the other numbers as probable derivatives. Natural hybridization is common in *Hypericum* [Kerner and Oliver(63)].

At the present state of our knowledge, nothing of definite phylogenetic value can be drawn from such studies as have been made on the secretory tissues or the cytogenetics of the genus.

In the one hundred odd species (plus numerous varieties and hybrids) of *Hypericum* that have been examined, no segregation of anatomical groups was possible. Rather the genus displayed in its vascular anatomy a very constant homogeneity. The herbs are of the reduced shrub type, possessing a continuous stele but with a reduction in the size of the central stele and a greater development of pith [Eames,(31) Sinnott and Bailey,(102) Sinnott,(101) Bews(10, chap. 4)]. The shrubs in turn are doubtless reductions of tropical tree ancestors, as they possess a generally more subtropical distribution than the herbaceous members.

In its minute anatomy, the genus *Hypericum* shows vessel members that are very short, generally extremely small and very numerous, with the end wall slightly oblique with simple perforations predominant, but with scalariform or clustered perforations occurring in certain species. The side-wall pitting is alternate, with a tendency to coalescence in contact with ray cells. Tracheids occur around the vessel in some members and show transitional stages to vessels. The rays are typically uniseriate (Plate 6, fig. 32), although bi- and triseriate rays are

occasionally found. They are heterogeneous type III and type II B, very numerous, extremely fine and extremely low to very low, with generally upright marginal cells. Parenchyma as such is absent. The fiber tracheids are septate or nonseptate and typically contain a nucleus (Plate 6, figs. 32, 33, 35, and 36). They are very short, very thin to thick-walled, and with bordered pit pairs usually. In general, one may say that in the members of the Asiatic sections the fiber tracheids are septate, with nuclei; the Mediterranean sections lack septations but have nuclei; the American sections are nonseptate and without nuclei. However, too many exceptions occur to make this statement as a general rule. Spiral thickenings are particularly well developed in the South American members of the section *Brathys* (Plate 6, fig. 34).

In considering the phylogenetic tree as proposed by Reuter(98) and others, from the sero-diagnostic technic, the writer and E. C. Abbe, under the guidance of Dr. K. S. Chester,(21) carried out a series of "precipitin reactions" in an attempt to test its application to plant relations. Within the ten species of *Hypericum* tested, the precipitation-reaction technic proved of no value in the segregation of species, but showed only homogeneity.

The genus *Ascyrum* is separated from *Hypericum* in being tetramerous (the author has observed many reversions to the pentamerous condition). R. Keller considers the separation of this genus as purely an artificial one. Certainly in the minute anatomy the species differ not at all from the members of *Hypericum*.

Brandza,(12) in considering the germination of the Hypericaceæ and Guttiferæ, finds that the embryo in the Hypericaceæ is like that in the tribe Clusieæ of the Guttiferæ, in having very small cotyledons, a large hypocotyl which elongates on germination, and a radicle which becomes the primary root of the plant.

The above consideration shows the genus *Hypericum* to be a very homogeneous one, the main variations occurring in the flower.

Included in the Hypericaceæ are a number of tropical genera (*Cratoxylon, Eliaea, Vismia, Psorospermum,* and *Haronga*). In an attempt to find the possible origin of the genus *Hypericum*, these genera were next examined. The tribes Cratoxyleæ and Vismeæ are separated with difficulty from the tribe Hypericaceæ. They differ mainly in being tropical trees with a 3- to 5-locular ovary and in having an embryo with cotyledons longer than the hypocotyl.

In their minute anatomy they differ in having (*a*) larger vessel elements (probably due to greater age), which are slightly oblique porous, and have alternate side-wall pitting (Plate 6, fig. 31); (*b*) the presence of parenchyma (vasicentric to confluent to metatracheal); and (*c*) nonseptate fibers with generally bordered pit pairs.

Guttiferæ.—Since the Hypericaceæ are usually placed in or near the Guttiferæ (text fig. 1), this group was next examined. In general, the morphological characters of the Guttiferæ differ but little from those of the Hypericaceæ, which are usually included or near the Guttiferæ. The Guttiferæ vary chiefly in being trees or shrubs, having leaves with lines of secretory canals and very numerous lateral nerves, and with stigmas sessile or subsessile. In floral characters and in the disposition of secretory canals they stand very near each other.

In their minute anatomy, except in the tribe Clusieæ, the Guttiferæ do not differ from the arborescent members of the Hypericaceæ. In this tribe the vessel member is slightly oblique to transverse porous (occasionally scalariform) but with opposite pitting on the tangential walls and with scalariform pitting on the radial walls; also, most of the members have septate fiber tracheids (Plate 3, fig. 18), and the rays are of a primitive type. Parenchyma is present in all members.

Brandza's(12) work on the embryo and its mode of germination, in this group, reveals some very striking variations. The tribe Clusieæ has an embryo with small cotyledons, an enlarged hypocotyl, and the radicle develops into the primary root. Germination is epigean (this was also true in *Hypericum*). In the Moronoboideæ and Garcinieæ the cotyledons are extremely small, the hypocotyl is enlarged, but the radicle develops but little and the main root is an adventitious root arising just below the cotyledons. Germination is hypogean. In the Calophylloideæ the embryo possesses large swollen cotyledons, a small swollen hypocotyl, and a well-developed radicle. The germination is hypogean.

These two families are obviously closely related. For convenience they might well be kept separate, yet, on the basis of the available evidence, they may be considered a part of the same family, as has been done by Engler, Wettstein, and others. Weill(123) relates the two groups through the subfamily Moronoboideæ of the Guttiferæ. Hochreutiner(54) combines the two

groups through *Psorospermum* and the subfamilies Calophylloideæ and Clusioideæ of the Guttiferæ. On the basis of minute anatomy and embryo structure, the writer believes this view of Hochreutiner to be correct, with *Hypericum* and its near relatives departing from the Clusioideæ, and the arborescent Hypericaceæ from the Calophylloideæ.

The Guttiferæ show various relationships, but the strongest, according to most authors, is with the Theaceæ. Engler and Prantl even suggest a possible genetical relationship. The Eucryphiaceæ, the Quiinaceæ, and the Dipterocarpaceæ are usually included as related families (text fig. 1). Hutchinson[59] characterizes his Guttiferales as the "advanced hypogynous type of the Theales with opposite leaves, often gland-dotted or lined; stamens united into bundles; no endosperm; sepals always imbricate."

Theaceæ.—The Theaceæ are of a more generalized type than the preceding family, with a scanty development of endosperm, numerous stamens, free or shortly connate, and with spirally arranged simple leaves.

In their minute anatomy they are characterized by having vessel members generally long, with highly oblique end walls, and with scalariform perforations (Plate 2, figs. 9 and 10) the bars of which are without a border, or bordered at the ends only. Intervascular pitting is dominantly transitional-scalariform to opposite. The fiber tracheids are nonseptate, with bordered pit pairs usually in a single line on the sides of the elements (Plate 2, figs. 8 to 10). Rays are of the general primitive type. The tribes Bonnetieæ, Asteropeieæ, and Tetrameristeæ depart from this in possessing vessel members with slightly oblique porous end walls and alternate side-wall pitting. The fiber tracheids in these sections are nonseptate, mostly long and thick-walled, but with bordered pits (Plate 2, figs. 8 and 12; Plate 3, fig. 13).

These tribes are seen to occupy an unusual position within this family. The Bonnetieæ, according to Engler and Prantl, in various characters, occupy a special position under the Theaceæ, and show in their morphology a remarkable analogy to the Kielmeyeroideæ of the Guttiferæ (a group which in the system of Bentham and Hooker is a part of the tribe Bonnetieæ in the Theaceæ). They differ mainly in lacking the secretory organs of the Guttiferæ. Engler and Prantl suggest that perhaps this

group stands as a connecting link between the Theaceæ and the Guttiferæ. The anatomical evidence would seem to bear this out.

The tribe Asteropeieæ, with its monotypic genus *Asteropeia*, has been placed (*a*) as the transitional genus to the Chlænaceæ, (*b*) as an abnormal tribe of the Flacourtiaceæ near the genus *Homalium*, and (*c*) in the Linaceæ. In the opinion of Engler and Prantl the structure of the ovaries justifies its place in the Theaceæ, and they suggest it as intermediate between the Theaceæ and the Flacourtiaceæ. The writer is inclined to the belief that this tribe should remain as rather an unusual tribe of the Theaceæ. It differs strongly from the flacourtiaceous woods in the presence of abundant paratracheal parenchyma, rays with most of the cells horizontally elongate or homogeneous, and in the possession of nonseptate, thick-walled fiber tracheids. The Chlænaceæ and Linaceæ were not examined, so that no evidence is available at present as to the possible relationship of the Asteropeieæ with these groups.

The tribe Tetrameristeæ, with its monotypic genus *Tetramerista*, has been placed by some authors, with or without reservation, in the Ochnaceæ. Hallier places it as a tribe of the Marcgraviaceæ. This tribe differs from the Ochnaceæ, in lacking stipules, is tetramerous, with 4 stamens and with anthers united by a connective. The ovary is 4-parted with a basically attached ovule in each carpel. The fruit is 4-seeded, berrylike, with leathery exocarp and fleshy mesocarp. The stem lacks the cortical bundles of the Ochnaceæ, and no vestured pits were observed. In its minute anatomy this tribe resembles in all characters the Caryocaraceæ, except in ray type and the presence of crystals in the genus *Caryocar* (compare Plate 2, fig. 12, and Plate 3, fig. 16). In floral morphology this tribe is advanced over the Caryocaraceæ, but would seem to express the development of tendencies noted in the Caryocaraceæ; that is, ovary 4- or 8- to 20-celled, ovules solitary in each cell, ascending, fruit rather drupaceous with a woody endocarp, breaking into 1-seeded parts.

On the basis of this evidence the writer suggests that this tribe be transferred to an affinity with the Caryocaraceæ.

The Theaceæ (Ternstrœmiaceæ) as conceived by Bentham and Hooker (text fig. 1) contained a larger number of groups that are now generally regarded as representing distinct families. Thus the Quiinaceæ, Caryocaraceæ, Marcgraviaceæ, Actinidia-

ceæ, and Saurauiaceæ are all generally considered within the circle of affinities of the Theaceæ.

Quiinaceæ.—Bentham and Hooker consider the Quiinaceæ as a tribe of the Guttiferæ, but all the other writers separate them as a distinct family, with a position near the Guttiferæ (text fig. 1). They differ from the latter mainly in possessing stipules, stamens definite in number, and leaves simple or pinnately lobed. In their anatomy they are essentially distinguished from the Guttiferæ by the absence of schizogenous resin canals, by the occurrence of lysigenous mucilage canals, and by possessing heterogeneous type I rays. The writer considers this group as having a similar level of development to that of the Guttiferæ, but as taking their origin in the Theaceæ.

Caryocaraceæ.—The Caryocaraceæ differ from the Theaceæ mainly in having leaves digitately 3- to 5-foliolate instead of simple, and in having subperigynous stamens. In their minute anatomy they differ in having vessel members with slightly oblique, porous end walls (or occasionally scalariform) with intervascular pitting alternate. The fiber tracheids are thick-walled to very thick-walled and have simple or slightly bordered pit pairs. The suggested relationship of this group to the tribe Tetrameristeæ has been noted above.

Marcgraviaceæ.—The Marcgraviaceæ differ from the Theaceæ mainly in being generally climbing and epiphytic shrubs, sterile flowers of the inflorescence variously modified, and without endosperm. Anatomically the group is very heterogeneous, displaying in the vessel members the range of variation from very oblique, scalariform perforation plates and opposite side-wall pitting (*Norantea*), to a slightly oblique, porous end wall and alternate to coalescent side-wall pitting (*Marcgravia*) (Plate 3, figs. 14 and 15). The fiber tracheids are nonseptate in *Norantea*, septate in *Marcgravia* and *Souroubea*. All have bordered pit pairs. The rays are all heterogeneous type I. The genus *Norantea* possesses the anatomical characters that would seem to link this family very closely to the Theaceæ.

Actinidiaceæ and Saurauiaceæ.—The Actinidiaceæ and the Saurauiaceæ are very closely related, and by some authors considered as one family (text fig. 1). They differ from the Theaceæ in having versatile anthers and numerous small seeds with copious endosperm. In their anatomy they do not differ widely from the Theaceæ. The Actinidiaceæ are climbers, frequently having unisexual flowers, styles numerous and free,

The Saurauiaceæ are erect trees or shrubs, flowers mostly perfect, styles 3 to 5, free or connate at the base. In their anatomy the Actinidiaceæ have long vessels, a few porous perforate members, paratracheal parenchyma scattered, as contrasted with the Saurauiaceæ with very long to extremely long vessel members and with abundant diffuse parenchyma. The writer believes these two groups might well remain separated, although they are closely related to each other, to the Theaceæ, and to the Dilleniaceæ. These two families are generally placed as the transitional group between the Theales and the Dilleniaceæ.

Dilleniaceæ.—The Dilleniaceæ are considered by all the authors as representing a basic family in this whole series. Their affinity to the Magnoliaceæ is especially suggested by their frequently occurring spirocyclic perianth and by their indefinite hypogynous and sometimes free carpels. Bentham and Hooker even included this group in the Ranales. By the characters mentioned above they differ from the Actinidiaceæ, Saurauiaceæ, and Theaceæ. In their anatomy little difference is noted. The bars on the scalariform-perforate end walls are mostly completely bordered, the parenchyma is mostly diffuse, and the fiber tracheids are similar to those in the above families. The rays are in general of a slightly more primitive type.

The groups thus far considered form a good sequence, from both the taxonomic and the anatomical points of view (text fig. 3).

In any consideration of other families that have been allied to the Guttiferæ, one must treat of the Eucryphiaceæ.

Eucryphiaceæ.—The Eucryphiaceæ were placed by Bentham and Hooker in the Rosaceæ. Hutchinson considers them between the Hypericaceæ and the Guttiferæ in the order Guttiferales (text fig. 1). The other authors consider them as belonging in the same complex with the Guttiferæ. They differ from the Guttiferæ in possessing intrapetiolar stipules, endosperm, free stamens, and simple to compound leaves. In their anatomy they differ in possessing vessel members that are long to very long, with the end wall highly oblique, scalariform-perforate (Plate 7, fig. 40), or occasionally reticulate or porous end walls. The bars are bordered only at the ends. The intervascular pitting is transitional, scalariform to opposite (Plate 7, fig. 40). The parenchyma is mainly diffuse but becomes terminal near the growth rings. The fiber tracheids are nonseptate, thick-walled, with bordered pit pairs in single rows. They lack secretory

canals. The rays are of an advanced type (heterogeneous type II). From this description it will be seen that in their anatomy they are nearer to the Dilleniaceæ than to the Guttiferæ in all but the ray structure. On this basis and that of their geographical distribution they are considered an outgrowth of the Dilleniaceæ.

The Ochnaceæ and the Dipterocarpaceæ are included in this series by most authors (text fig. 1). Bentham and Hooker place the Ochnaceæ in the Geraniales and Hutchinson places the Ochnaceæ and Dipterocarpaceæ in his Theales.

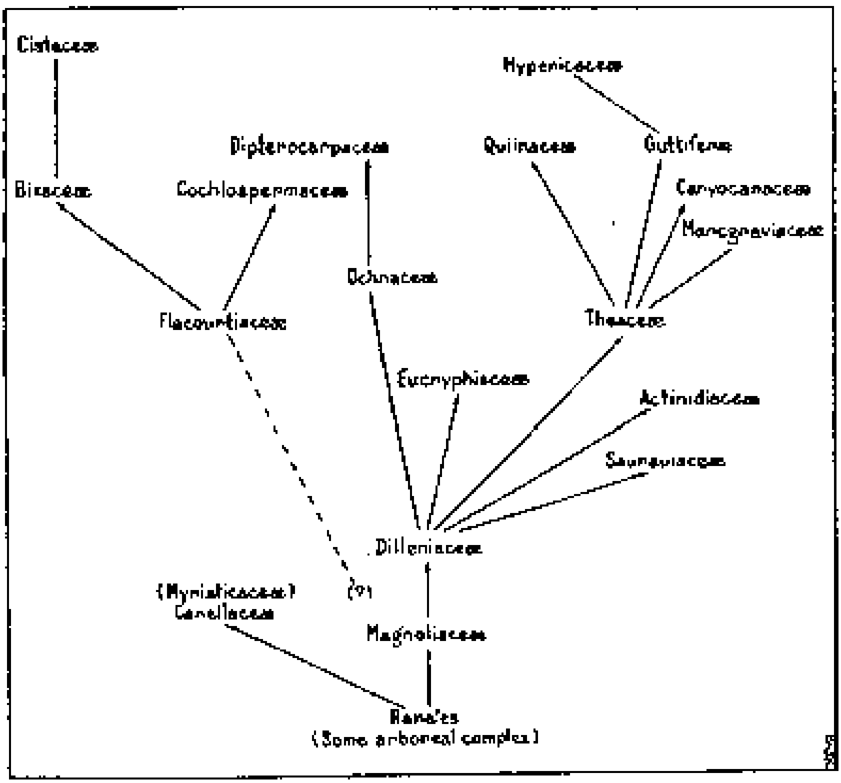

FIG. 3. Families of angiosperms.

Ochnaceæ.—The Ochnaceæ in *Ochna* and *Ouratea* possess a spirocyclic floral structure, characteristic of the Dilleniaceæ, but as in the Dilleniaceæ a reduction has occurred in the andrœcium and gynœcium. Also they possess stipules. Anatomically they differ greatly from the Dilleniaceæ in having vessel members short, with oblique porous end walls. The intervascular pitting

is alternate. The parenchyma is paratracheal, metatracheal, and diffuse, the metatracheal being most common in the genus *Lophira* (Plate 7, fig. 42; Plate 8, fig. 43). The fiber tracheids are nonseptate or septate, mostly thick-walled and long. The pit pairs are simple or slightly bordered. A common anatomical feature is the presence of leaf-trace bundles in the cortex (Rendle).

As has been mentioned in the description of this family, the two subfamilies Exalbuminosæ and Albuminosæ are separated on the basis of the presence or absence of endosperm. Anatomically they can be separated by the presence of vestured pits in the Exalbuminosæ, lacking in the Albuminosæ as shown by Bailey.(3) In the Albuminosæ the upright ray cells are more elongate, thus making the rays more heterogeneous (thus more primitive) than is found in the other tribe. Also we find septate fiber tracheids in certain of the Albuminosæ, as contrasted with their complete absence in the Exalbuminosæ.

The genus *Lophira* of the Exalbuminosæ seems to be something of a critical genus in the family, in that it combines characters of the Ochnaceæ with certain of those of the Dipterocarpaceæ. It differs from the latter in lacking resin canals, in the stratification of the bast that is characteristic in that family, and in ray type. It agrees in possessing two outer sepals that become much elongated in the fruit to form a wing, and in having vestured pits and well-developed metatracheal parenchyma. Bentham and Hooker consider *Lophira* to be a genus of the Dipterocarpaceæ. On the basis of similarity in floral structure and tendencies in the minute anatomy of the Exalbuminosæ, the writer feels that this genus may well be transitional to the Dipterocarpaceæ, though it be treated as belonging to the Ochnaceæ.

Dipterocarpaceæ.—The Dipterocarpaceæ differ from the preceding family in possessing a calyx that becomes enlarged and winglike in fruit (it is found in the Ochnaceæ only in the genus *Lophira*) and fruit mostly 1-seeded with endosperm lacking. Anatomically they differ in containing secretory canals in the xylem with metatracheal parenchyma well developed, and rays of a more advanced type. The writer believes this family stems in the Exalbuminosæ of the Ochnaceæ, with the connecting genus probably *Lophira*. The Dipterocarpaceæ and Ochnaceæ agree in lacking endosperm, in the presence of vestured pits, in the development of parenchyma, and in the presence of cortical bundles. Although the Dipterocarpaceæ have occasionally

been allied to the Guttiferæ due to the presence of the secretory canals, the writer regards the latter as a parallel development.

The families so far discussed seem to the author to be rather a homogeneous group, all stemming in the Dilleniaceæ (text fig. 3). There are variations in flowers, leaves, endosperm, and anatomy, but always in clearly defined lines. They are in agreement in having strongly developed parallel lateral veins in the leaf, widely imbricate calyx lobes, nutritive tissue of the seed containing oil and protein bodies, and generally axile placentation. In their anatomy the vessels vary from primitive to derived, but possess none of the highly evolved vessel types. The fiber tracheids vary in the same manner; even in the most highly developed groups in this series, one still finds slightly bordered pit pairs. In the vessel-to-ray pitting, most members still possess a half-bordered pit pair. Rays are with few exceptions heterogeneous and vary from primitive to derived.

Considered in this group or closely allied to it is the Parietales or Bixales complex. Since this group is considered in the line of origin of the Theales and Guttiferales of Hutchinson, the writer deems it desirable to consider them in the light of Hutchinson's position. This group contains, according to Hutchinson, the Bixaceæ, Cochlospermaceæ, Flacourtiaceæ, Canellaceæ, and Cistaceæ. Hutchinson characterizes them as " a woody to rarely subherbaceous group in which syncarpy with parietal placentation has remained a fixed character." As he considers them as stemming in the Dilleniaceæ, they will be considered in that light.

Bixaceæ.—The Bixaceæ differ from the Dilleniaceæ in having syncarpy, parietal placentation, anthers horseshoe-shaped, testa fleshy, leaves palmately lobed, and endosperm starchy. In their anatomy they differ in having vessel members short, slightly oblique to transverse porous (Plate 9, fig. 50); intervascular pitting alternate; wood parenchyma in strands 4 cells tall; fiber tracheids nonseptate, very thin-walled and very short, with bordered pit pairs rare; rays heterogeneous type II.

Cochlospermaceæ.—The Cochlospermaceæ differ from the preceding in having anthers straight or nearly so, and the fruit a 3- to 5-valved capsule. In the anatomy the vessel members are long (Plate 8, fig. 48); parenchyma paratracheal and with conspicuous metatracheal bands 5 to 8 cells wide.

Flacourtiaceæ.—The Flacourtiaceæ differ from the preceding two families in having stipules early deciduous, flower perfect, monœcious or diœcious, rarely polygamous, ovary superior to

inferior, 1-celled of 2 to 10 united carpels, and fruit indehiscent, mostly a berry or drupe, very rarely a capsule. In their anatomy they differ in having vessel members ranging from very long to very short. The end wall is typically porous, but scalariform perforation plates occur in several members of the lower tribes Oncobeæ and Pangieæ. Intervascular pitting is typically alternate, but here again the earlier two tribes Oncobeæ and Pangieæ possess transitional pitting. Parenchyma is typically absent, and when present is scanty and paratracheal. Rays are of a generally more primitive type. The fiber tracheids are generally septate with thin walls and with simple or slightly bordered pit pairs. In members possessing the thick-walled fibers a definite concentric appearance is seen in transverse section.

This family is seen to possess a wide range of varying structures. This leads the writer to believe that this more generalized family is more primitive than the preceding two. The tribes contained in this family are obviously related but possess tendencies in several directions. The anatomical evidence falls in line with the phylogenetic conclusions proposed by Engler and Prantl.

Cistaceæ.—The Cistaceæ, generally considered the most highly evolved of this group, differ from the previously discussed families in being a group of herbs and shrubs with generally opposite leaves, petals fugaceous, sepals contorted, seeds with bent, coiled, or folded embryo. In their anatomy they differ in lacking parenchyma (like the Flacourtiaceæ), having very inconspicuous rays, the fiber tracheids nonseptate and very short (Plate 9, fig. 51).

The Cistaceæ have been considered as closely related to the Hypericaceæ [Turner (117)], but the writer sees them rather as two end lines of parallel series at the same level of development. They seem to stand nearest to the Bixaceæ, which in turn stem in the Flacourtiaceæ. The Cochlospermaceæ seem to be a parallel development also arising in the Flacourtiaceæ.

This complex of families seems to be a line completely apart from the previously discussed series. It is even doubtful whether they take their origin in the same group. The Flacourtiaceæ are the only ones that show in their anatomy any relationship to the Dilleniaceæ, and Wettstein's idea that they stem in the Rhoeadales should be considered before a definite statement can be made.

Hutchinson's consideration of this group as basic for the Theales and Guttiferales should be disregarded. It is rather

difficult to conceive of the obviously primitive vessel members in the Theaceæ, Actinidiaceæ, and Saurauiaceæ as coming from the highly evolved vessel members of the Bixales series. The same is true regarding the ray types in the two series.

This whole series differs from the preceding series in having parietal placentation as a fixed character, in possessing stipules (also present in a few families of the other series), in having leaves palmately veined or without prominent parallel lateral veins, sepals slightly imbricate to valvate, endosperm copious and starchy, vessel members and ray type generally of an advanced type, fiber tracheids generally thin with only slightly bordered pit pairs.

Canellaceæ.—The family Canellaceæ is placed in this series by Bentham and Hooker, Hutchinson, and Engler and Prantl, but by Wettstein and Bessey is considered as belonging to the Polycarpicæ or Ranales along with the Magnoliaceæ (text fig. 1). It seems to occupy an unusual position from both the taxonomic and the anatomical point of view. Morphologically they are characterized as bisexual, cyclic, oligomerous, syncarpous, oligocarpous, endosperm oily and fleshy, embryo straight and very small, stamens few(20) and connate, leaves spiral and simple with stipules lacking. Anatomically the vessel members are mostly very long, end wall highly oblique, scalariform perforation plate, with crossbars completely bordered or bordered at the end to the middle. The intervascular pitting is transitional to opposite. The parenchyma is asymmetrically paratracheal, occurring on one side of the vessel members only (Plate 9, fig. 52), or occasionally diffuse. The rays are homogenous types I and III, mostly type III (Plate 9, figs. 53 and 54). The fiber tracheids are nonseptate with thin or thick walls, and have well-developed bordered pit pairs.

Gilg in Engler and Prantl states that on the presence of oil glands in the cortex, pith, and leaves, the character of the minute anatomy of the stem and the irregular number and spiral arrangement of petals in *Cinnamodendron* show relationship to the Magnoliaceæ. He further states that in the disposition of oil glands and in the coalescence of stamens, this group stands near the Myristicaceæ. Wettstein places the Canellaceæ as a family of the Polycarpicæ, next to the Myristicaceæ. Gilg, however, despite the other relationships that he mentions, believes this group to be a parallel development with the Fla-

courtiaceæ from a ranalian source and thus includes them in the Parietales.

The evidence presented shows that this family does not fit in either of the lines presented. It differs from the Parietales complex, where it has been most generally placed, in lacking stipules, having few stamens which are connate, and in possessing oily endosperm. In its minute anatomy it differs in all the characters noted above.

Concerning its relation to the Myristicaceæ, it has been noted that in the disposition of oil glands and coalescence of stamens this family shows relationship. Further points in its favor are the oily endosperm, small straight embryo, reduced number of sepals, petals, and stamens, and short style. In the minute anatomy of the Myristicaceæ as reported by Garratt(41) the scalariform type of vessel was found in all woods examined, although rare in some, intervascular pitting was alternate or opposite, though in some cases showing a more or less pronounced scalariform arrangement. The fiber tracheids have walls generally thin to very thin, with slightly bordered or simple pit pairs. The rays are usually distinctly heterogeneous, but are weakly heterogeneous to even homogeneous in some cases. Garratt,(42) although not relating the two groups closely, states that they do have definite characters in common.

It seems to the writer that this family, on all the available evidence, should be taken out of the Parietales-Guttiferales complex and placed near the Myristicaceæ as Wettstein and Bessey have done.

Magnoliaceæ.—Since the Magnoliaceæ are generally considered as the source of these groups, they will be characterized briefly. They are trees and shrubs, having perfect, cyclic, polymerous apocarpic flowers, large stipules, simple leaves, the stamens numerous and free, and the endosperm oily and copious. In their anatomy [McLaughlin(73) and checked by the writer] the vessel members are generally long with a highly oblique scalariform perforation with few to numerous bars. The intervascular pitting is transitional to scalariform, rarely opposite. The fiber tracheids are short to very long, tapering gradually to a point, and have circular bordered pit pairs with slitlike apertures. These characters on the basis of the dicta set forth page 225 show this group to be very primitive, as has been considered by a great many authors.

III. ADDITIONAL OBSERVATIONS

These observations,[5] outside of the secondary vascular anatomy, are given as additional supportive evidence of the phylogenetic lines as seen by the writer.

(*a*) *Spicular cells.*—Spicular cells in the mesophyll are always present in the Theaceæ, but are also found in the Dilleniaceæ, Guttiferæ, Ochnaceæ, Dipterocarpaceæ, and Flacourtiaceæ. They are generally of specific value only. In the above it will be noted that they occur in one major line of development, except for the Flacourtiaceæ, which are considered basal in the other line.

(*b*) *Secretory tissue.*—The presence of secretory cavities and canals has long been used as a taxonomic character. This character is variable in nature, content, and position. In the groups discussed, it occurs as characteristic of the Guttiferæ, Hypericaceæ, and Dipterocarpaceæ. Large, thin-walled oil or resin cells are found in the families Magnoliaceæ, Canellaceæ, Myristicaceæ, and others of that complex.

(*c*) *Cortical vascular bundles.*—The presence of cortical vascular bundles with a collateral structure may not always be of phylogenetic importance in the broadest sense, but may be used to show affinities within a restricted group. In the above-treated families this character is universally distributed in the Ochnaceæ and Dipterocarpaceæ.

(*d*) *Bast.*—Although not a great deal is known of bast structure, the presence of alternating layers of hard and soft bast may well show definite relationship within a large series. In the present group of families, alternating hard and soft bast is reported in the Magnoliaceæ, Dilleniaceæ, Canellaceæ, Bixaceæ, Cochlospermaceæ, Theaceæ, Guttiferæ, Ochnaceæ, and Dipterocarpaceæ.

(*e*) *Sero-diagnostic technic.*—Reuter,(95) in developing the phylogeny of the Parietales, places the Dilleniaceæ as a short branch from the main stem; next above he places a branch containing as lateral branches the Ochnaceæ, Hypericaceæ, Caryocaraceæ, Theaceæ, Bixaceæ, and Cistaceæ; above this as separate branches from the main stem appear the Canellaceæ and Dipterocarpaceæ. The Flacourtiaceæ are considered as on the main

[5] Unless otherwise stated, these observations are taken from Solereder.(104)

line above these families. The writer's observations on the members of the genus *Hypericum* [Chester, Abbe, and Vestal (21)], showed only homogeneity. The above results of Reuter are not in accord with the writer's disposition of these families (text fig. 3). It is introduced here as an interesting arrangement of this complex.

(*f*) *Nodal anatomy.*—Sinnott (101) gives the following lacunar condition in the families considered in this work: Dilleniaceæ, 3; Actinidiaceæ, 1; Saurauiaceæ, 1; Theaceæ, 1; Marcgraviaceæ, 1; Caryocaraceæ (not given); Guttiferæ, 1; Hypericaceæ, 1 (author's observation); Quiinaceæ (not given); Eucryphiaceæ, 3; Ochnaceæ, 3; Dipterocarpaceæ, 3 and 5; Flacourtiaceæ, 3; Cochlospermaceæ (not given); Bixaceæ, 3; Cistaceæ, 1; Canellaceæ (not given); Magnoliaceæ, 1 to 3 and many.

In this study the trilacunar condition is brought forward as the most primitive condition in the angiosperms. In using the node as an aid in the classification of the angiosperms, it will be noted that the Dilleniaceæ-Theaceæ line has a trilacunar to unilacunar condition; the Dilleniaceæ-Eucryphiaceæ-Ochnaceæ-Dipterocarpaceæ line is trilacunar, except that the Dipterocarpaceæ may also possess five. The Flacourtiaceæ-Bixaceæ-Cistaceæ line is seen to have a tri-, tri- to a unilacunar series. The Magnoliaceæ, considered a basic family, have a uni-, tri-, to many-lacunar condition.

CONCLUSIONS

The proposed phylogenetic sequence of the families studied is graphically summarized in text fig. 3. Text figure 3 is meant to show only the writers' phylogenetic conception of these groups at the present time. It is not meant to be a final disposition of these families. Additional evidence, particularly cytological, may do much in aiding a more final arrangement of this complex.

The anatomical method, while not final, certainly points to levels of development that are very important in the arrangement of a natural sequence. Definite anatomical trends and occasionally specific characters, if taken within a broad complex, aid in clearing the way for a more orderly arrangement of the families. Within a family the slight heterogeneity in the anatomy may be misleading, unless its phylogenetic background is known. Also, in comparing isolated families, homogeneity may indicate a level of development, rather than true relationship. To find the anwser, an inclusive study of allied families must be made.

The series of families examined seems to fall logically into two large complexes, the Parietales and Guttiferales of Wettstein (text figs. 1 and 3). The order Parietales, defined by Engler and Prantl as heterogeneous, proves to be such both on the basis of general morphology and secondary vascular anatomy. The subseries Theineæ within this order proves more homogeneous, but is probably composed of various lines coming from the Dilleniaceæ and Theaceæ (compare text figs. 1 and 3). It is a matter of opinion whether these should be segregated as separate orders as Wettstein and others have done or kept as a subseries of the Parietales. However, due to the heterogeneity of the group Parietales, it is believed that the splitting of this large complex makes for a more homogeneous understanding of the order.

The Bixales of Hutchinson should not be considered as the point of origin of the Theales and Guttiferales on the basis of their secondary anatomy. The line Dilleniaceæ to Theaceæ is a great deal more homogeneous when all the factors are considered.

In the writer's opinion, the Canellaceæ do not belong to this complex of families. It is suggested that this family could well be placed somewhere near the Myristicaceæ and the arboreal Ranales.

In general, Wettstein's treatment of these families is more in accord with the author's findings than any of the other systems considered.

SUMMARY

From this broad study certain salient facts stand out.

1. Vascular anatomy may be of use as a taxonomic tool, especially within large complexes in indicating levels of development, and in the disposition of certain debatable groups.

2. Correlations between dimensions, perforation plates and pitting of vessel members, pitting and dimensions of fiber tracheids, and the type of rays, prove to be of particular phyletic import in this study.

3. The groups logically fall into two major complexes, nearer the taxonomic treatment of Wettstein; namely, the Parietales and the Guttiferales, or that of Engler and Prantl's Parietales with its attendant subseries. The former is preferred. The treatment of Hutchinson does not fall in line with the observed anatomical evidence.

4. The Dilleniaceæ, Theaceæ, and Flacourtiaceæ are considered as possible groups within the complex from which the other lines have radiated.

5. The Canellaceæ are considered as being more closely related to the Myristicaceæ and the arboreal Ranales than to the above groups.

6. The Hypericaceæ on all available evidence would seem to be a logical outgrowth from the Guttiferæ. It is a matter of personal opinion whether the group should remain as a part of the Guttiferæ or be considered as a separate family.

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ILLUSTRATIONS

These photomicrographs were made with a Bausch and Lomb J. camera, Bausch and Lomb photographic microscope with Zeiss apochromatic objectives, and, in the main, Zeiss Homal oculars.

The particular magnification used in making each picture is indicated with its description.

So far as is known, all the material was correctly identified, but the possibility of misidentification must not be left out of consideration, especially since these are all wood specimens and therefore difficult to check with herbarium material. The writer has not concerned himself with synonomy in specific names, as the main problem is centered around the family.

In the following photomicrographs the number of the slide is given. *R* following the number indicates that the material is from Prof. S. J. Record, *B* indicates the Prof. I. W. Bailey's collection, and *B. L.* indicates a slide in the Harvard Biological Laboratories collection.

PLATE 1

FIG. 1. *Dillenia Reifferschiedia* Spach. (3462 B), Dilleniaceæ. Transverse section, showing distribution of pores, fiber tracheids, and rays. × 45.

2. *Dillenia Reifferschiedia* Spach. (3462 B), Dilleniaceæ. Tangential section, showing multi- and uniseriate rays, pitting of fiber tracheids, and indication of vessel end wall. × 45.

3. *Dillenia luzoniensis* (Vid.) Merr. (4420 R), Dilleniaceæ. Section of vessel end wall, showing bordered scalariform bars, occluded with a tylosis. × 225.

4. *Schumacheria castaneifolia* Vahl. (2632J B), Dilleniaceæ. Radial section showing intervascular scalariform pitting. × 55.

5. *Saurauia submodesta* Diels. (4954 R), Saurauiaceæ. Radial section showing vessel end, intervascular pitting, palisade ray cells, and fiber-tracheid pitting. × 110.

6. *Saurauia nudiflora* DC. (1102 B), Saurauiaceæ. Tangential section showing multiseriate rays with upright sheath cells, uniseriate rays and fiber tracheids. × 100.

PLATE 2

FIG. 7. *Schima supera* Gord. (21868 R), Theaceæ. Transverse section showing a growth ring and distribution of pores and fiber tracheids. × 45.

FIG. 8. *Ploiarium alternifolium* (Vahl.) Melch. (15441 R), Theaceæ. Tangential section showing porous vessel ends, intervascular pitting, rays, and fiber tracheids. × 55.

9. *Schima superba* Gard. (21868 R), Theaceæ. Radial section showing vessel ends, fiber tracheids, and rays. × 100.

10. *Camellia japonica* L. var. *spontanea* Makino (14591 R), Theaceæ. Radial section showing vessel ends, intervascular pitting, and cluster pitting in parenchyma. × 100.

11. *Tetramerista glabra* Miquel (8223 R), Theaceæ. Transverse section showing distribution of pores, fiber tracheids, parenchyma, and rays. × 55.

12. *Tetramerista glabra* Miquel (8223 R), Theaceæ. Tangential section showing intervascular pitting, tyloses in end wall, rays, and fiber tracheids. × 55.

PLATE 3

FIG. 13. *Bonnetia tristyla* Gl. (16186 R), Theaceæ. Radial section showing vessel ends, fiber tracheids, and vessel-ray pitting. × 45.

14. *Marcgravia rectiflora* Tr. and Planch. (1379 R), Marcgraviaceæ. Radial section showing vessel end, intervascular pitting, and septate fiber tracheids. × 55.

15. *Souroubea guianensis* Aubl. (552 R), Marcgraviaceæ. Radial section showing vessel end, intravascular pitting, vessel-ray pitting, and fiber tracheids. × 55.

16. *Caryocar villosum* (Aubl.) Pers. (22576 R), Caryocaraceæ. Tangential section showing rays, fiber tracheids, and septate parenchyma containing crystals. × 63.

17. *Chrysochlamys membranacea* Planch. (20962 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

18. *Chrysochlamys membranacea* Planch. (20962 R), Guttiferæ. Radial section showing scalariform intervascular pitting and septate fiber tracheids. × 100.

PLATE 4

FIG. 19. *Mammea americana* L. (2702 R), Guttiferæ. Transverse section showing distribution of elements. × 55.

20. *Allanblackia parviflora* A. Chev. (15232 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

21. *Garcinia Mannii* Oliv. (15780 R), Guttiferæ. Transverse section showing distribution of elements. × 55.

22. *Calophyllum montanum* Vieill. (14226 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

23. *Platonia insignis* Mart. (13615 R), Guttiferæ. Transverse section showing distribution of elements. × 45.

24. *Hypericum perforatum* L. (B. L.), Hypericaceæ. Transverse section showing distribution of elements. × 45.

PLATE 5

FIG. 25. *Garcinia corymbosa* Wall. (14025 R), Guttiferæ. Tangential section showing rays, fiber tracheids, vessel members, and parenchyma. × 45.

26. *Platonia insignis* Mart. (13615 R), Guttiferæ. Tangential section showing vessel members, rays, fiber tracheids, and parenchyma. × 55.

27. *Mammea americana* L. (2702 R), Guttiferæ. Tangential section showing secretory canals in the rays, and fiber-tracheid pitting. × 55.

28. *Calophyllum montanum* Vieill. (14426 R), Guttiferæ. Tangential section showing vessel members, rays, and fiber tracheids. × 45.

29. *Kayea assamica* Prain. (9587 R), Guttiferæ. Radial section showing vessel members, parenchyma, ray cells, and pitting of fiber tracheids. × 110.

30. *Caraipa* sp. (21335 R), Guttiferæ. Tangential section showing vessel members, rays, and fiber tracheids. × 45.

PLATE 6

FIG. 31. *Haronga madagascarensis* Choisy (11135 R), Hypericaceæ. Tangential section showing intervascular pitting, rays, and fiber tracheids. × 55.

32. *Hypericum adpressum* Bart. (B. L.), Hypericaceæ. Tangential section showing rays, septate fiber tracheids with nuclei, and vessel members. × 76.

33. *Hypericum Androsaemum* L. (B. L.), Hypericaceæ. Radial section showing vessel members, septate fiber tracheids with nuclei (some dividing), and ray cells. × 83.

34. *Hypericum chamaemyrtos* Trian. (B. L.), Hypericaceæ. Radial section showing vessel members with spiral thickenings, ray cells, and fiber tracheids. × 75.

35. *Hypericum atomarum* Boiss. (B. L.), Hypericaceæ. Radial section showing vessel members with types of perforation and fiber tracheids. × 75.

36. *Hypericum atomarum* Boiss. (B. L.), Hypericaceæ. Radial section showing types of vessel perforations and fiber tracheids with nuclei. × 75.

PLATE 7

FIG. 37. *Quiina Cruegeriana* Griseb. (1115 R), Quiinaceæ. Tangential section showing rays, fiber tracheids, and vessel members. × 55.

38. *Eucryphia Billardieri* Spach. (19658 R), Eucryphiaceæ. Transverse section showing distribution of elements. × 45.

39. *Eucryphia Moorei* F. v. Müll. (19336 R), Eucryphiaceæ. Tangential section showing vessel members and fiber tracheids and rays. × 55.

FIG. 40. *Eucryphia Moorei* F. v. Müll. (19336 R), Eucryphiaceæ. Radial section showing vessel members and ray cells. × 55.

41. *Ouratea agrophylla* Urb. (16697 R), Ochnaceæ. Transverse section showing distribution of elements. × 45.

42. *Lophira alata* Banks (19764 R), Ochnaceæ. Transverse section showing distribution of elements. × 45.

PLATE 8

FIG. 43. *Lophira alata* Banks (19764 R), Ochnaceæ. Radial section showing parenchyma, fiber tracheids, vessel members, and ray cells. × 45.

44. *Ouratea agrophylla* Urb. (16697 R), Ochnaceæ. Tangential section showing rays, vessel members, intervascular pitting, and fiber tracheids. × 55.

45. *Elvasia* sp. (2100 R), Ochnaceæ. Tangential section showing vessel members, rays, parenchyma, and fiber tracheids. × 55.

46. *Dipterocarpus Dyerii* Pierre (13147 R), Dipterocarpaceæ. Transverse section showing distribution of elements. × 45.

47. *Dipterocarpus Dyerii* Pierre (13147 R), Dipterocarpaceæ. Tangential section showing rays and fiber tracheids. × 55.

48. *Cochlospermum vitifolium* (Willd.) Spreng. (277 B), Cochlospermaceæ. Tangential section showing vessel members with intervascular pitting, parenchyma, rays, and fiber tracheids. × 45.

PLATE 9

FIG. 49. *Bixa Orellana* L. (17294 R), Bixaceæ. Transverse section showing distribution of elements. × 55.

50. *Bixa Orellana* L. (17294 R), Bixaceæ. Tangential section showing storied arrangement of rays, vessel members, and parenchyma strands. × 55.

51. *Lechea maritima* Leggett (E. L.), Cistaceæ. Radial section showing vessel members, ray cells, and fiber tracheids. × 75.

52. *Canella Winterana* Gaertn. (23378 R), (Canellaceæ). Transverse section showing distribution of elements. × 83.

53. *Capsicodendron pimenticra* Hoche (22444 R), Canellaceæ. Radial section showing rays, parenchyma, and fiber tracheids. × 45.

54. *Canella Winterana* Gaertn. (23378 R), Canellaceæ. Tangential section showing rays (some cells with crystals) and fiber tracheids with pitting. × 83.

TEXT FIGURES

FIG. 1. Phylogenetic trends of angiosperms.

2. Variations in the genus *Hypericum*.

3. Families of angiosperms.

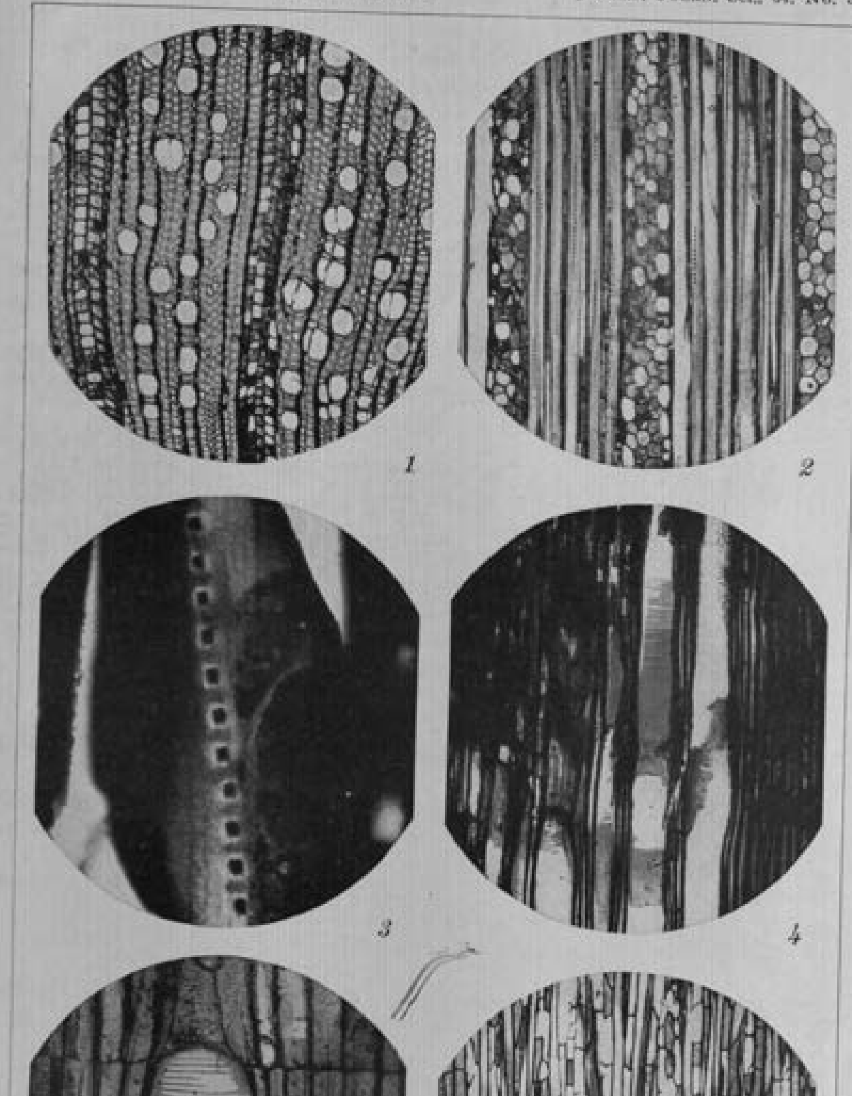
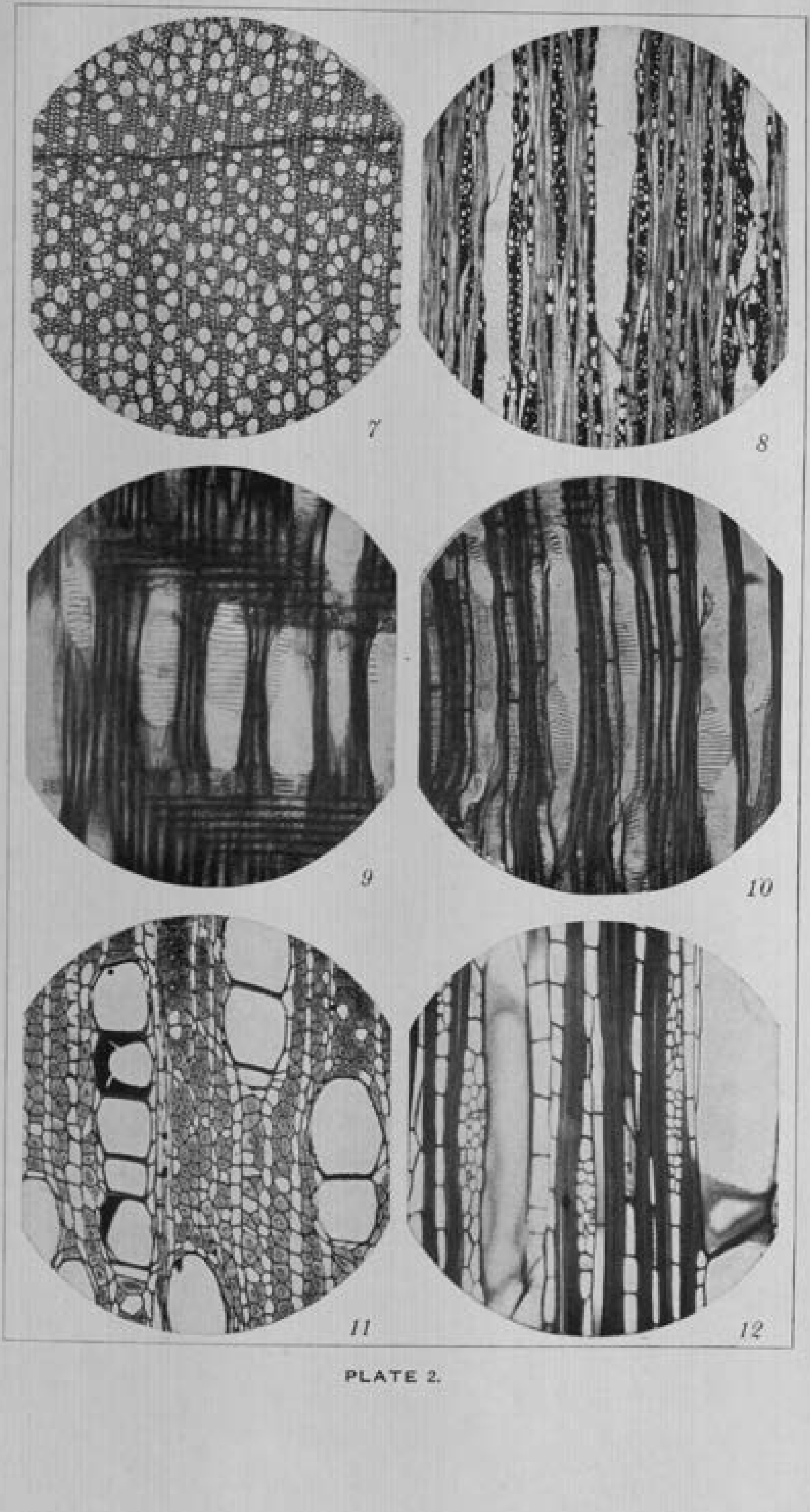


PLATE 1.



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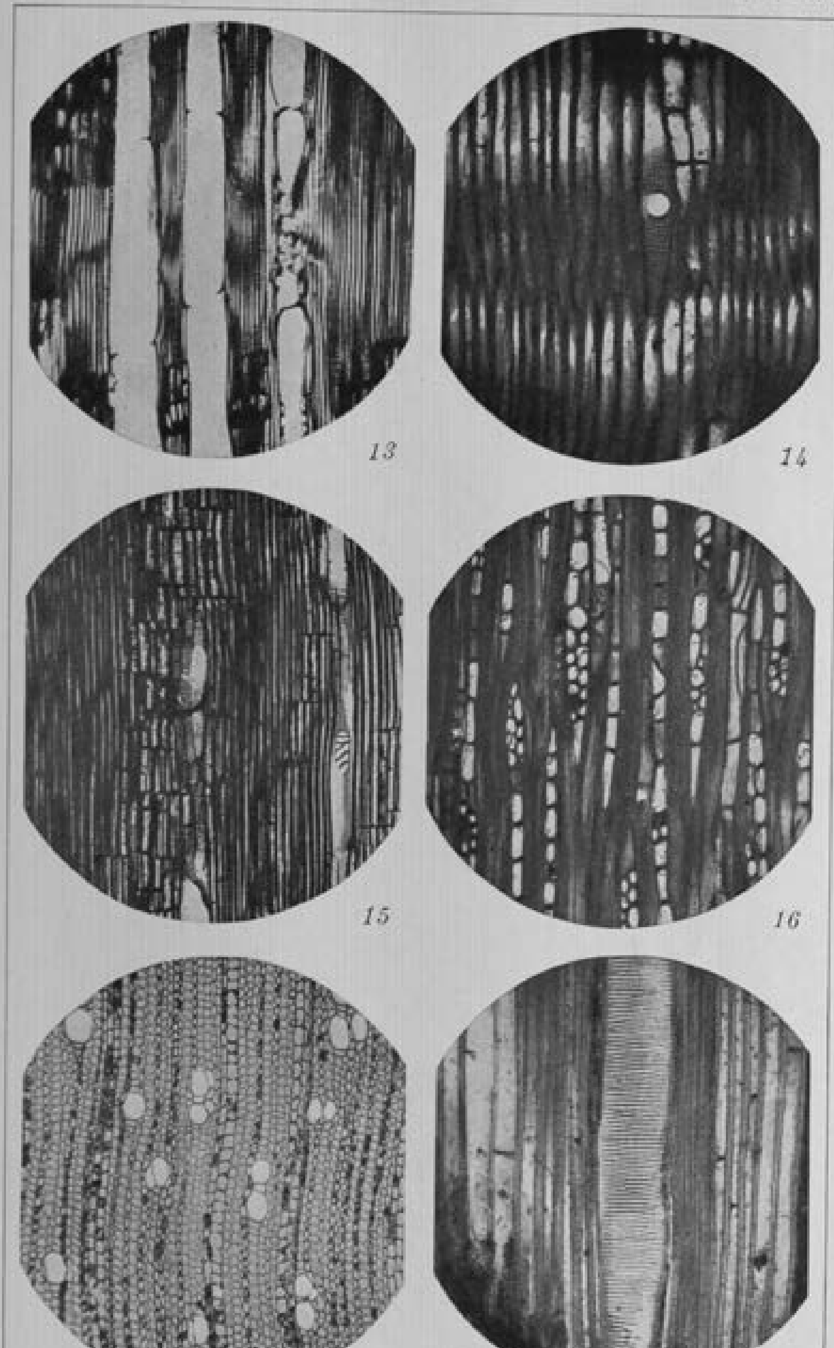

PLATE 3.

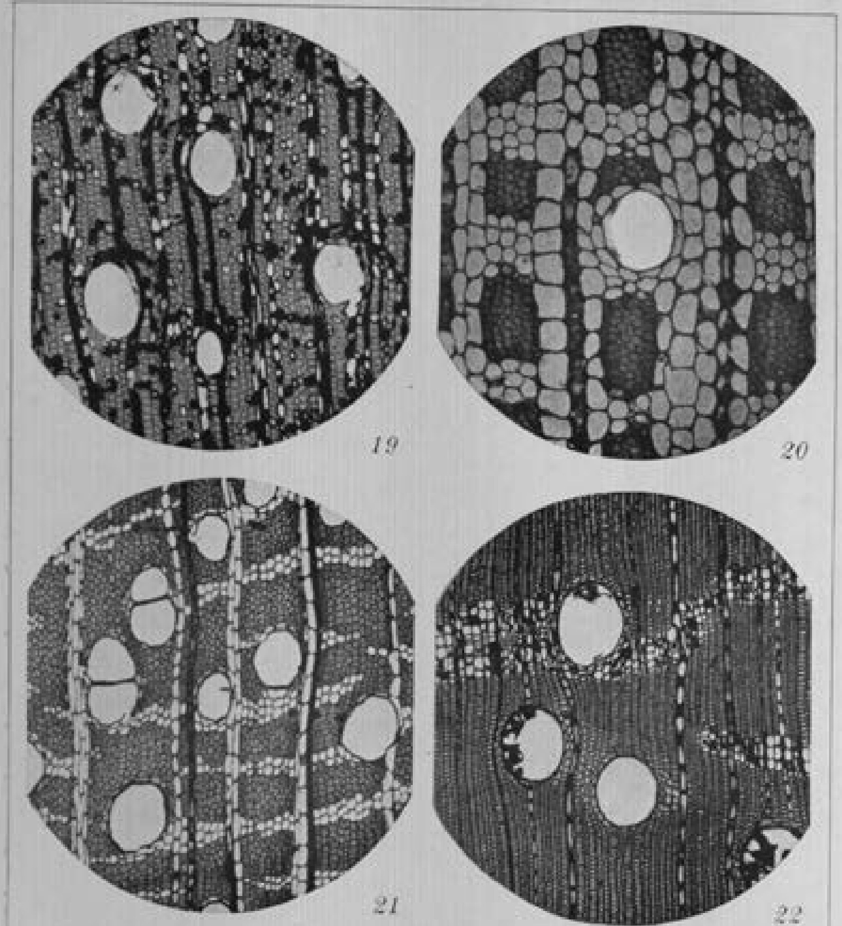

PLATE 4.

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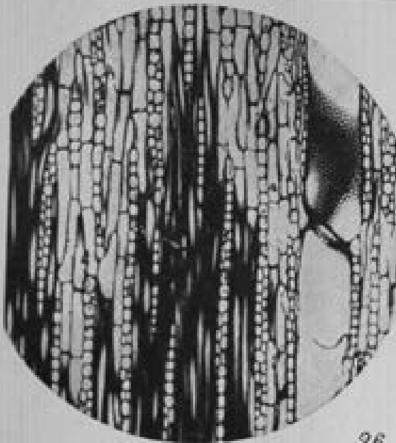

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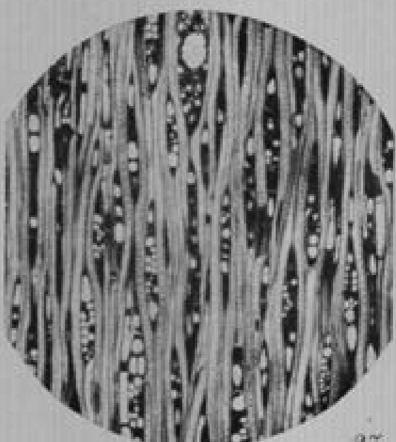

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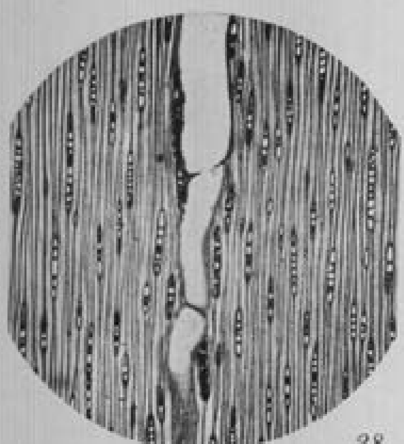

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PLATE 5.

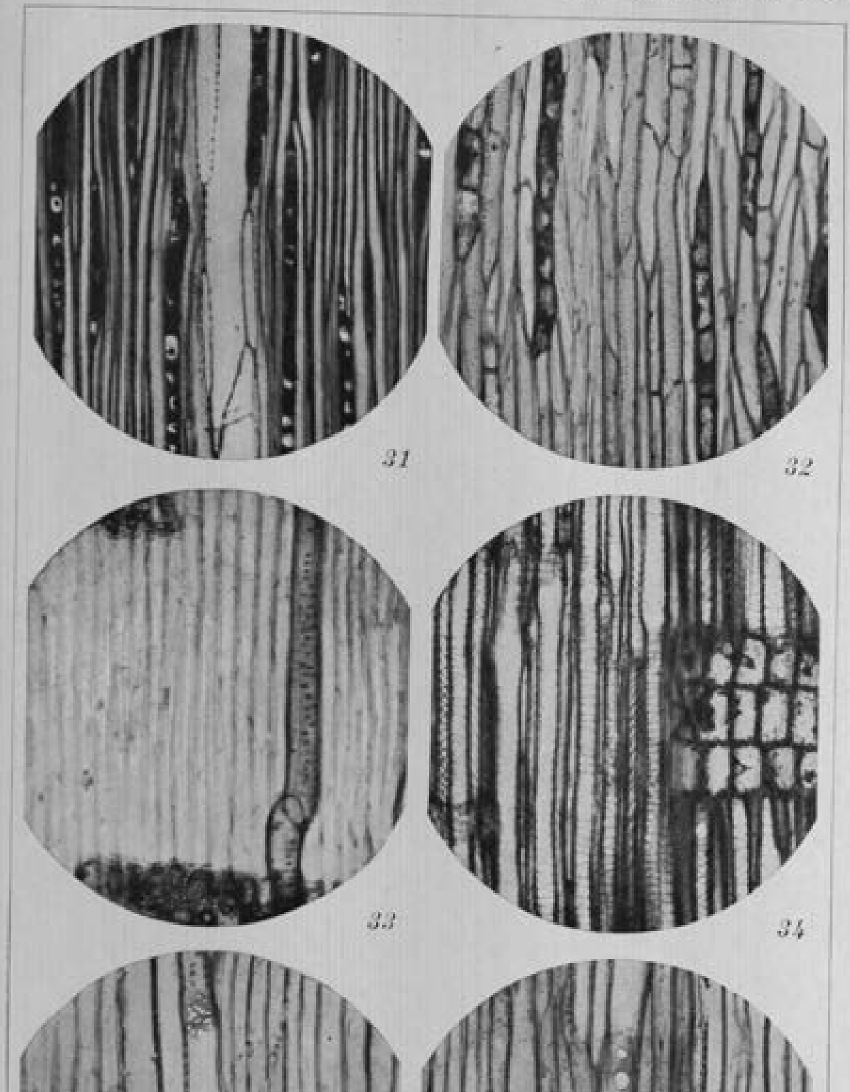

PLATE 6.

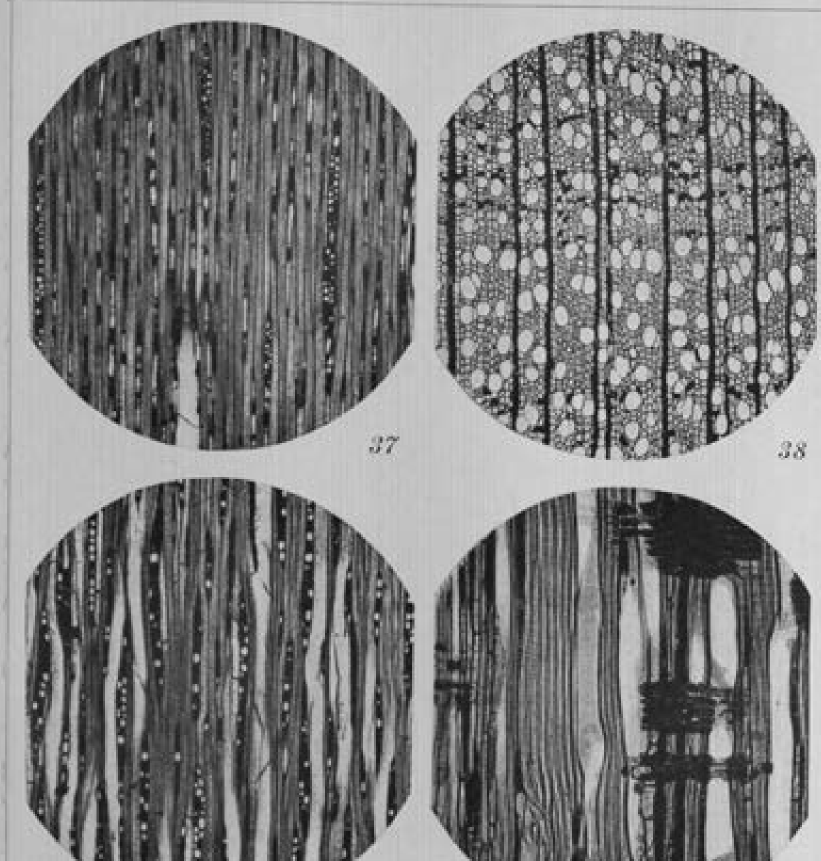

PLATE 7.

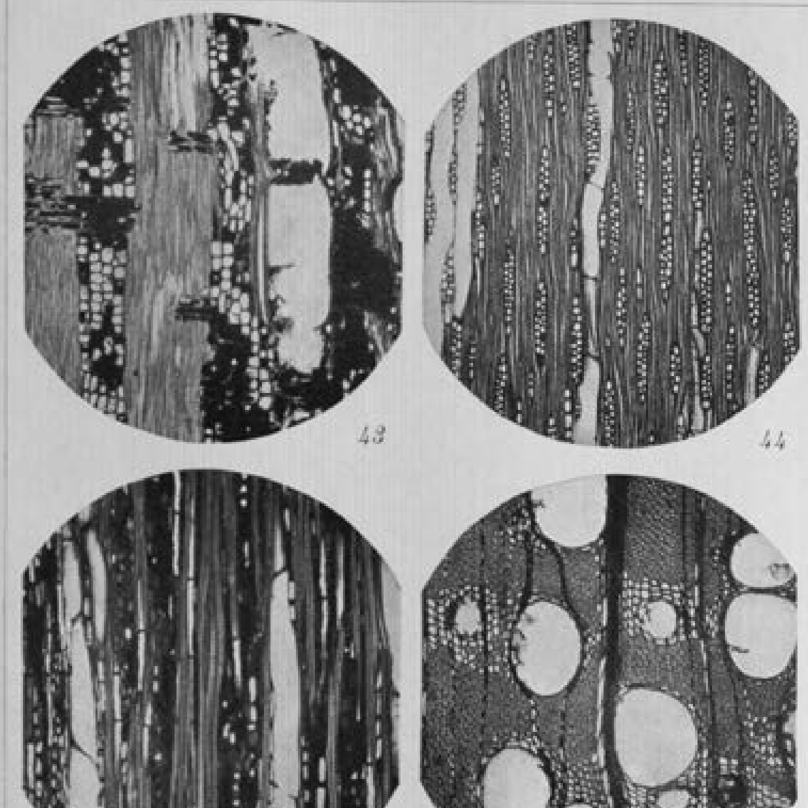

PLATE 8.

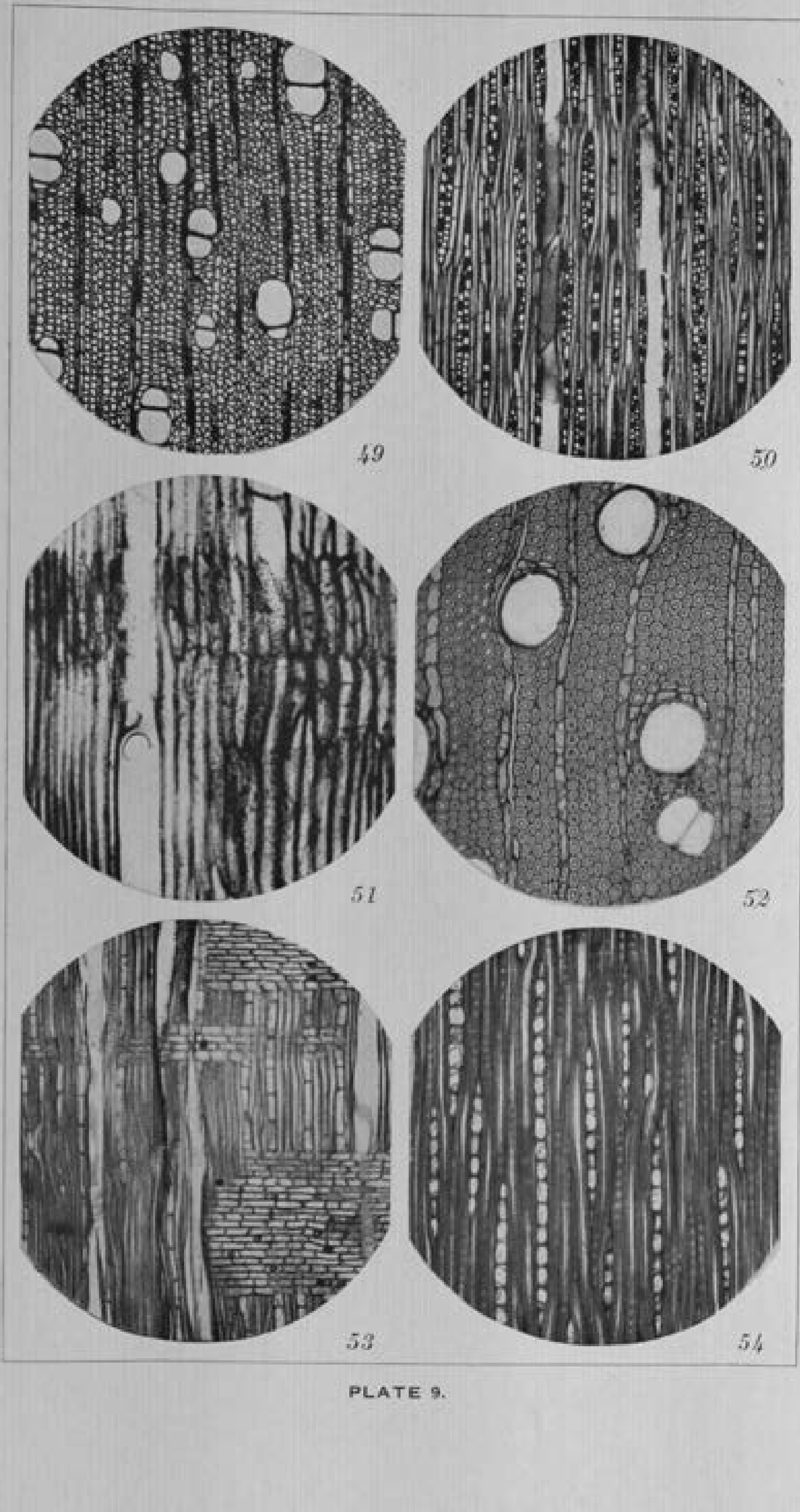

PLATE 9.

NEMATODES IN THE COLLECTION OF THE PHILIPPINE BUREAU OF SCIENCE, III

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Of the Bureau of Science, Manila

THREE PLATES

Superfamily STRONGYLOIDEA Weinland, 1858

Family TRICHOSTRONGYLIDÆ Leiper, 1912

Genus MOLINEUS Cameron, 1923

MOLINEUS ASIATICUS sp. nov. Plate 1, figs. 4 to 6.

Specific diagnosis.—Molineus: Body small, slender, more or less straight in contour. Cephalic vesicle slightly developed, about 0.05 millimeter long, separated from rest of body by a constriction; a second constriction occurs more posteriorly near level of nerve ring. Cuticle with faint traces of transverse striation in region of cephalic vesicle, elsewhere presenting longitudinal lines. Cephalic and cervical papillæ apparently absent. Œsophagus long, without a distinct bulb. Nerve ring slightly in front of middle of œsophageal length; excretory pore immediately behind that level.

Male: Length 3.6 to 3.8, maximum diameter 0.05 to 0.06 millimeters. Cuticle with 18 equidistant longitudinal lines. Œsophagus 0.24 to 0.27 millimeter long. Bursa well developed, 0.14 by 0.15 millimeter, distinctly divided into two large lateral lobes and a small dorsal lobe, central portions of lateral lobes covered with small spines. Arrangement of bursal rays shown in Plate 1, fig. 6. Ventral rays long, parallel, arising from a common trunk but separated in their distal halves, directed ventro-anteriorly and reaching the edge of the bursa. Lateral rays also with a common trunk, the externolateral slightly thicker but much shorter than the other lateral rays and directed ventrally. Mediolateral and posterolateral rays long and parallel, directed dorsally and reaching bursal edge. Externodorsal rays slightly longer than dorsal ray, but only a little more than one-half as long as the medio- and posterolateral rays. Dorsal ray terminating in two short tridigitate branches,

the middle digit in each branch being the smallest. Spicules 72 to 78 microns long, slightly curved, their proximal ends club-shaped and their distal extremities each terminating in two needlelike processes. Gubernaculum a slender rod, curved ventrally, about 40 microns long.

Female: Length 4.5 to 4.8, maximum diameter 0.05 to 0.06 millimeters. Cuticle with 20 longitudinal striations. Œsophagus 0.28 to 0.31 millimeter long. Posterior end of body rounded, with a ventral knoblike prominence and a terminal spine about 12 microns long. Vulva 0.8 to 1 and anus 0.08 to 0.12 millimeter, respectively, from posterior end. Eggs in uterus thin-shelled, in the one- to two-cell stage, 47 to 49 by 26 to 28 microns.

Host.—*Paradoxurus philippinensis* Jourdan.

Location.—Small intestine.

Locality.—Balanga, Bataan Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 530.

Remarks.—The genus *Molineus* also includes *M. felineus* Cameron, 1923; *M. torulosus* (Molin, 1861); and *M. europæus* Zunker, 1929. Compared with these three species, the Philippine representative appears to be most similar to *M. felineus*. Table 1 shows the differences between *M. felineus* and *M. asiaticus*.

TABLE 1.—*Comparison of Molineus felineus and Molineus asiaticus.*

Species.	Size.		Length of spicule.	Length of gubernaculum.
	Male.	Female.		
	mm.	mm.	μ	μ
M. felineus	4.75×1	a5.25×1	120	60
M. asiaticus	3.6-3.8×0.05-0.06	4.5-4.8×0.05-0.06	72-78	40

Species.	Bursa.	Externolateral ray.
M. felineus	Not distinctly divided into lobes.	Separated from mediolateral ray only near tip.
M. asiaticus	Distinctly divided into lobes.	More completely separated from mediolateral ray.

a Cameron's figure "1 mm." for the diameter of *M. felineus* may have been meant for "0.1 m."

Family DIAPHANOCEPHALIDÆ Travassos, 1919

Genus KALICEPHALUS Molin, 1861

KALICEPHALUS sp. Plate 3, figs. 4 and 5.

This nematode is represented in the collection by three female specimens (No. 498) obtained from a cobra. It has been compared with *Kalicephalus minutus* (Baylis and Daubney, 1922), *K. najæ* Maplestone, 1931, and *K. radicus* Bhalerao, 1931, all of which are also parasites of cobras; but in view of the lack of male specimens a specific diagnosis has not been made.

Description.—Kalicephalus: Length 6.5 to 7.0, maximum width 0.35 millimeters, rounded anteriorly and gradually tapering posteriorly into a pointed tail about 0.3 millimeter long. Head compressed laterally, 0.18 millimeter in dorsoventral diameter, 0.13 millimeter in lateral diameter, marked off from rest of body by a very slight constriction. Buccal capsule 0.10 millimeter in maximum dorsoventral diameter, with two valves characteristic of the genus. Each valve with three straight parenchymatous bands, the medial one thicker than the laterals. Duct of œsophageal gland extending more than half the distance into buccal cavity. Œsophagus 0.3 millimeter long, with a distinct posterior bulb. Nerve ring around narrowest part of œsophagus, or immediately in front of middle of its length. Cervical papillæ and excretory pore inconspicuous, opposite middle of œsophageal bulb. Uteri divergent, ovejectors well developed. Vulva prominent, 2.5 millimeters from posterior end. Eggs in utero thin-shelled, segmented, 72 by 42 microns.

Host.—Naja naja philippinensis Taylor.

Location.—Intestine.

Locality.—Alabang, Rizal Province, Luzon.

Superfamily SPIRUROIDEA Railliet and Henry, 1915

Family SPIRURIDÆ Oerley, 1885

Genus METABRONEMA Yorke and Maplestone, 1926

METABRONEMA CARANXI sp. nov. Plate 2, figs. 1 to 6.

Specific diagnosis.—Metabronema: Body elongate, slightly tapering near both extremities. Cuticle transversely striated, the intervals between the striations gradually increasing from 3 to 25 microns in the male and from 4 to 30 microns in the female towards the posterior end of the body. A cuticular band

about 50 microns wide on each side of the body and extending from near the anterior level of the glandular œsophagus to near the posterior end of the worm. Bands more prominent in the male than in the female. Mouth with two rounded lateral lips and surrounded by four submedian papillæ. Pharynx in the form of a narrow tube. Œsophagus divided into an anterior muscular and a posterior glandular portion, the former usually bent or twisted. Nerve ring a short distance behind junction of pharynx and œsophagus.

Male: Length 19, maximum width 0.6 millimeters. Head about 0.15 millimeter in diameter. Pharynx 0.18 to 0.20 millimeter long. Total length of œsophagus 5.8 to 6.7 millimeters, the muscular portion 0.78 to 1.04 and the glandular portion 5.05 to 5.65 millimeters long. Cervical papillæ 0.09 millimeter, nerve ring 0.3 millimeter, and excretory pore 0.7 millimeter, respectively, from anterior end. Posterior extremity spirally coiled, describing one and a half to two complete turns. Cuticle of ventral half of this region of the body as far as caudal alæ thrown into longitudinal folds. Caudal alæ moderately developed. Spicules very dissimilar: right spicule elongate, 1.16 to 1.25 millimeters long by 0.03 millimeter in maximum width at proximal end; left spicule of peculiar shape, 0.34 to 0.40 by 0.05 millimeter. Gubernaculum absent. Nine pairs of genital papillæ, arranged as follows: four pairs of pedunculated papillæ precloacal, four pairs postcloacal, one pair of sessile papillæ subterminal. Cloacal opening about 0.4 millimeter from posterior end.

Female: Length 65 to 70, maximum witdh 1.3 millimeters. Head 0.25 millimeter in diameter. Pharynx 0.23 to 0.29 millimeter long. Total length of œsophagus 10.5 to 12.4 millimeters, the muscular portion 1.18 to 1.27 and the glandular portion 9.35 to 11.10 millimeters long. Cervical papillæ 0.18, nerve ring 0.45, and excretory pore 0.8 millimeter, respectively, from anterior end. Vulva behind junction of anterior and middle thirds of body length, about 25 millimeters from anterior end, and surrounded by a suckerlike prominence. Eggs in utero thick-shelled, embryonated, 42.7 to 45.7 by 24.5 to 26 microns, with polar knobs from each of which two or more filaments arise. Anus 0.3 to 0.4 millimeter from posterior end. Tail bluntly conical.

Host.—*Caranx speciosus* (Forskål).

Location.—Abdominal cavity.

Locality.—San Narciso, Tayabas Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 529.

Remarks.—This parasite presents a striking resemblance to *Metabronema magna* (Taylor, 1925), and was at first thought identical with that species, considering that *M. magna*, according to Taylor's description, appears to be a very variable species, and that it has also been reported by Baylis (1934) from a fish in Australia specifically identical with the host of *M. caranxi*. The differences between *M. magna* and *M. caranxi* are shown in Table 2.

TABLE 2.—*Comparison of Metabronema magna and Metabronema caranxi.*

Species	Ratio of length of anterior portion of œsophagus to length of posterior portion. Male.	Ratio of length of anterior portion of œsophagus to length of posterior portion. Female.	Length of right spicule.
			mm.
M. magna	1:3	1:3	1.79–1.83
M. caranxi	1:6	1:8	1.06–1.23

Species.	Location of vulva.	Eggs.	Gubernaculum.
M. magna	Between 1st and 2d thirds of body length.	37 × 23 μ segmented	Present.
M. caranxi	Behind junction of 1st and 2d thirds of body length.	42.9–45.7 × 24.5–26 μ embryonated.	Absent.

Genus GONGYLONEMA Molin, 1857

GONGYLONEMA sp. Plate 1, fig. 1.

This nematode is represented in the collection by two adult female specimens (No. 509) obtained from a rodent, *Crateromys schadenbergi*. In view of the paucity of material, a specific determination has not been made.

Description.—*Gongylonema:* Length 30 to 50, maximum width 0.18 to 0.24 millimeters. Cuticular plaques extend posteriorly to a level 1.3 to 1.6 millimeters from anterior end of body. Vestibule (pharynx) 0.065 millimeter long. Œsophagus 3.6 to 4.5 millimeters in total length, anterior portion 0.53 to 0.55 and the posterior portion 3.07 to 4.02 millimeters long. Nerve ring 0.25 to 0.27 millimeter from anterior end of body. Vulva 4.4 to 5.9 millimeters and anus 0.13 to 0.17 millimeter, respectively,

from posterior end. Eggs thick-shelled, embryonated, 57.8 to 64.2 by 32 to 34 microns.

Host.—*Crateromys schadenbergi* (Meyer).

Location.—Under mucosa of stomach.

Locality.—Nueva Vizcaya Province, Luzon.

Family RICTULARIIDÆ Railliet, 1916

Genus RICTULARIA Froelich, 1802

RICTULARIA PARADOXURI sp. nov. Plate 3, figs. 1 to 3.

Specific diagnosis.—*Rictularia:* Sexual dimorphism marked, females very much larger than males. Cuticle transversely striated, distance between striations 7.5 to 22 microns in the male and 13 to 28 microns in the female. Mouth directed anterodorsally and surrounded by two ventral and two dorsal papillæ and two lateral amphids. Buccal capsule well developed, with a pair of short conical teeth at its base. Œsophagus divisible into three regions, depending upon the degree of chitinization, the first two short chitinized portions corresponding to anterior muscular portion of œsophagus of other spirurid nematodes. Nerve ring in front of middle of second œsophageal portion. Cervical papillæ in female opposite junction of second and third divisions of œsophagus, in male behind that level.

Male: Length 6.0 to 7.5, maximum width 0.5 to 0.6 millimeters, with 60 to 64 pairs of subventral combs and spines extending from level opposite base of buccal capsule to a level about 0.9 millimeter from cloacal opening. There are also 4 medial combs between last pair of subventral spines and cloacal opening. Œsophagus 2.1 to 2.4 millimeters in total length, anterior portion about 0.14 and second portion 0.28 millimeter long. Nerve ring 0.25 and cervical papillæ 0.5 to 0.6 millimeter, respectively, from anterior extremity. Posterior end of body conical, either bent or slightly coiled ventrally, and apparently without lateral alæ. Ten pairs of sessile genital papillæ, three pairs of these precloacal and seven pairs postcloacal. As shown in Plate 3, fig. 3, the first four pairs of postcloacal papillæ occur in two rows grouped closely together a short distance behind cloacal opening, while the last three pairs are located near the posterior end. Spicules almost equal, right 220 to 260 and left 212 to 255 microns long. Gubernaculum absent.

Female: Length 29 to 32, maximum width 1.05 to 1.12 millimeters, with 92 pairs of subventral combs and spines, of which

46 to 49 are prevulvar and 43 to 46 postvulvar. The postvulvar combs gradually assume the form of spines and reach posteriorly to a level 2.05 to 2.65 millimeters in front of anus. Œsophagus 4.9 millimeters in total length, anterior portion about 0.2 and the middle portion 0.5 millimeter long. Nerve ring 0.42, cervical papillæ 0.84 and vulva 6.5 to 7.0 millimeters, respectively, from anterior end of body. Anus 0.4 to 0.5 millimeter from tip of pointed posterior end. Eggs in utero thick-shelled, in morula stage, 37.8 to 41.5 by 22.6 to 26 microns.

Host.—*Paradoxurus philippinensis* Jourdan.

Location.—Intestine.

Locality.—Balanga, Bataan Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 531.

Remarks.—This nematode bears a very close resemblance to *Rictularia houdemeri* Hsu, 1935, a parasite of *Viverra zibetha*, a near relative of the host of the Philippine parasite. The differences between the two species are shown in Table 3.

TABLE 3.—*Comparison of Rictularia houdemeri and Rictularia paradoxuri.*

Species.	Length of female.	Number of combs and spines.		Distance from anterior end to vulva.	Size of eggs.
		Male.	Female.		
	mm.			mm.	μ
R. houdemeri	9.35–16.93	65–66	116–118	2.36–3.28	36–39 × 27–29
R. paradoxuri	23–32	60–64	92	6.50–7.00	37.8–41.5 × 22.6–26

Superfamily FILARIOIDEA Weinland, 1858

Family FILARIIDÆ (Cobbold, 1864) Claus, 1885

Genus CHANDLERELLA Yorke and Maplestone, 1926

CHANDLERELLA LEPIDOGRAMMI sp. nov. Plate 1, figs. 1 to 3; Plate 3, fig. 6.

Specific diagnosis.—*Chandlerella:* Body elongate, slightly tapering towards both extremities. Cuticle with faint transverse striations. Mouth simple, surrounded by two pairs of submedian papillæ and a pair of amphids. Œsophagus divided into a short anterior muscular portion and a long posterior glandular portion. Nerve ring around junction of middle and posterior thirds of anterior œsophageal region. Excretory pore behind nerve ring, about 0.4 millimeter from anterior end in both sexes, or opposite junction of two œsophageal regions.

Male: Length 30 to 35, maximum width 0.5 to 0.7 millimeters. Posterior end of body spirally coiled, describing one and a half to two complete turns. Œsophagus 2.15 millimeters in total length, anterior portion about 0.25 and posterior portion 1.9 millimeters long. Nerve ring 0.18 to 0.20 millimeter from anterior end. Caudal alæ absent. Spicules almost equal, trough-shaped, 245 to 260 microns long by 45 microns in maximum width, each carrying at its proximal extremity a mass of brownish spongy substance. Genital papillæ few and arranged as follows: one unpaired median precloacal papilla, three pairs of submedian postcloacal papillæ, and one unpaired median terminal papilla (Plate 3, fig. 6). Cloacal opening about 0.16 millimeter from posterior end.

Female: Length 50 to 55, maximum width 0.9 millimeters. Posterior end of body broadly rounded, with a small unpaired subterminal papilla. Œsophagus 2.7 millimeters in total length, anterior muscular portion 0.38 millimeter long. Nerve ring about 0.25 millimeter from anterior end. Vulva opposite junction of anterior and middle thirds of length of glandular œsophagus or 1 to 1.2 millimeters from anterior end of body. Vagina about 3 millimeters long. Eggs in utero thin-shelled, embryonated, 94.5 to 100.5 by 51 to 53 microns. Anus 0.15 millimeter from posterior end.

Host.—*Lepidogrammus cumingi* (Fraser).

Location.—Cœlome.

Locality.—Virac, Albay Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 520.

Remarks.—The genus *Chandlerella* was proposed by Yorke and Maplestone (1926) for a bird parasite which was described by Chandler (1924) under the name *Filaria bosci*. Recently Li (1933) placed in the same genus another bird nematode, *C. sinensis*, which, like the Philippine species, differs from the genotype in the structure of the œsophagus and in the arrangement of the uteri. *Chandlerella lepidogrammi* may be distinguished from *C. sinensis*, as shown in Table 4, by its larger size, the position of the vulva, the length of the œsophagus in proportion to body length, and the length of the spicules.

TABLE 4.—*Comparison of Chandlerella sinensis and Chandlerella lepidogrammi.*

Species.	Size.		Distance from anterior end to vulva.
	Male.	Female.	
	mm.	mm.	mm.
C. sinensis	15–18 × 0.14–0.17	23–25 × 0.23–0.26	0.36–0.43
C. lepidogrammi	30–35 × 0.60–0.70	50–55 × 0.90	1.20

Species.	Ratio of length of oesophagus to body length.		Length of spicules.
	Male.	Female.	
			μ
C. sinensis	1:25	1:33	Unequal; right 70–80, left, 60–50.
C. lepidogrammi	1:15	1:19	Almost equal, 245–260.

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ILLUSTRATIONS

[Drawn by D. Escuadro.]

PLATE 1

FIG. 1. *Chandlerella lepidogrammi* sp. nov., anterior end of female, lateral view.
2. *Chandlerella lepidogrammi* sp. nov., posterior end of female, lateral view.
3. *Chandlerella lepidogrammi* sp. nov., posterior end of male, lateral view.
4. *Molineus asiaticus* sp. nov., anterior end of male, lateral view.
5. *Molineus asiaticus* sp. nov., posterior end of female, lateral view.
6. *Molineus asiaticus* sp. nov., posterior end of male, dorsal view.
7. *Gongylonema* sp., anterior end of female, lateral view.

PLATE 2. METABRONEMA CARANXI SP. NOV.

FIG. 1. Anterior end of female, lateral view.
2. Anterior end of female, ventral view.
3. Mouth and papillæ, anterior view.
4. Posterior end of female, lateral view.
5. Posterior end of male, lateral view.
6. Egg showing polar filaments and inclosed embryo.

PLATE 3

FIG. 1. *Rictularia paradoxuri* sp. nov., anterior end of female, lateral view.
2. *Rictularia paradoxuri* sp. nov., anterior end of female, dorsal view.
3. *Rictularia paradoxuri* sp. nov., posterior end of male, lateral view.
4. *Kalicephalus* sp., anterior end of female, lateral view.
5. *Kalicephalus* sp., posterior end of female, lateral view.
6. *Chandlerella lepidogrammi* sp. nov., posterior end of male, ventral view.

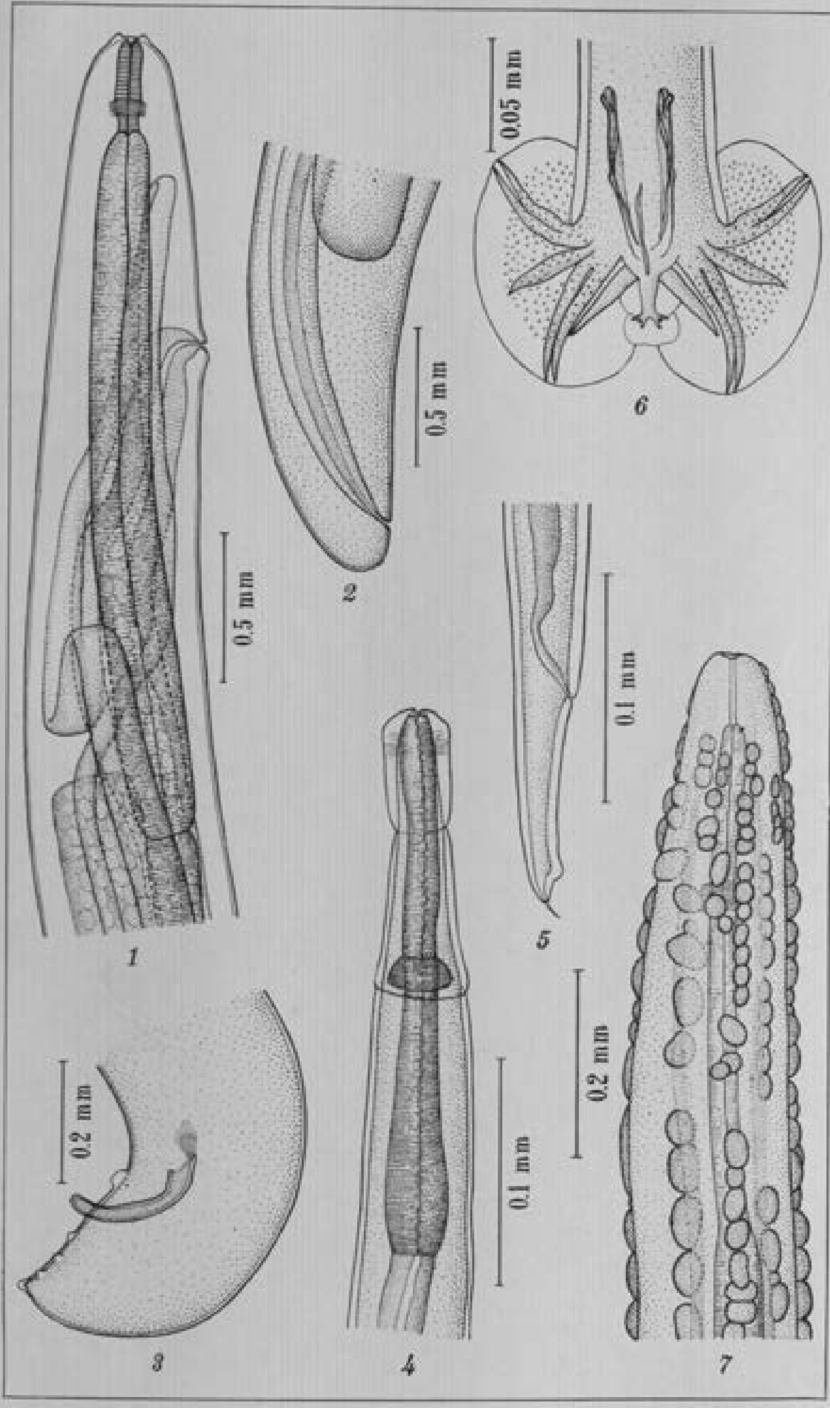

PLATE 1.

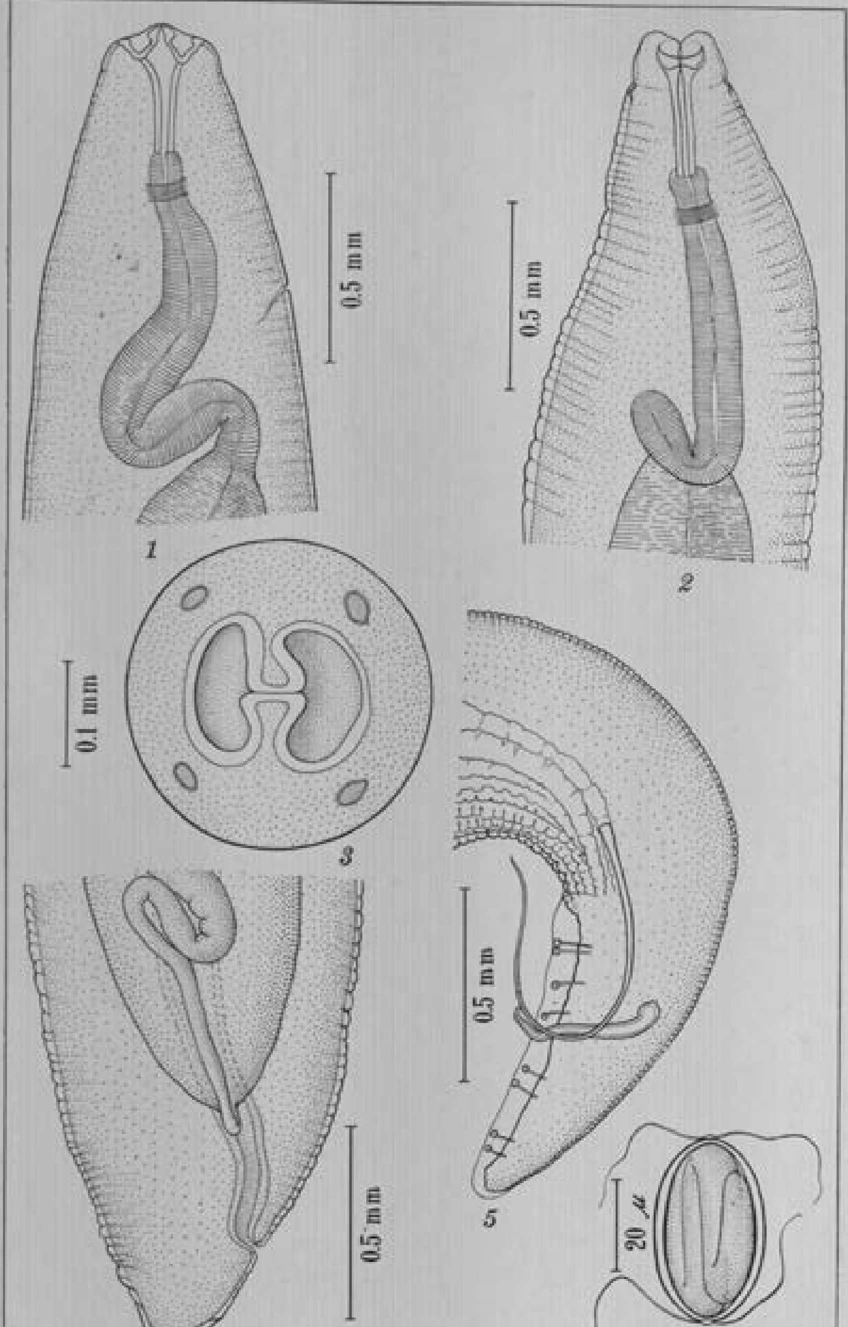

PLATE 2.

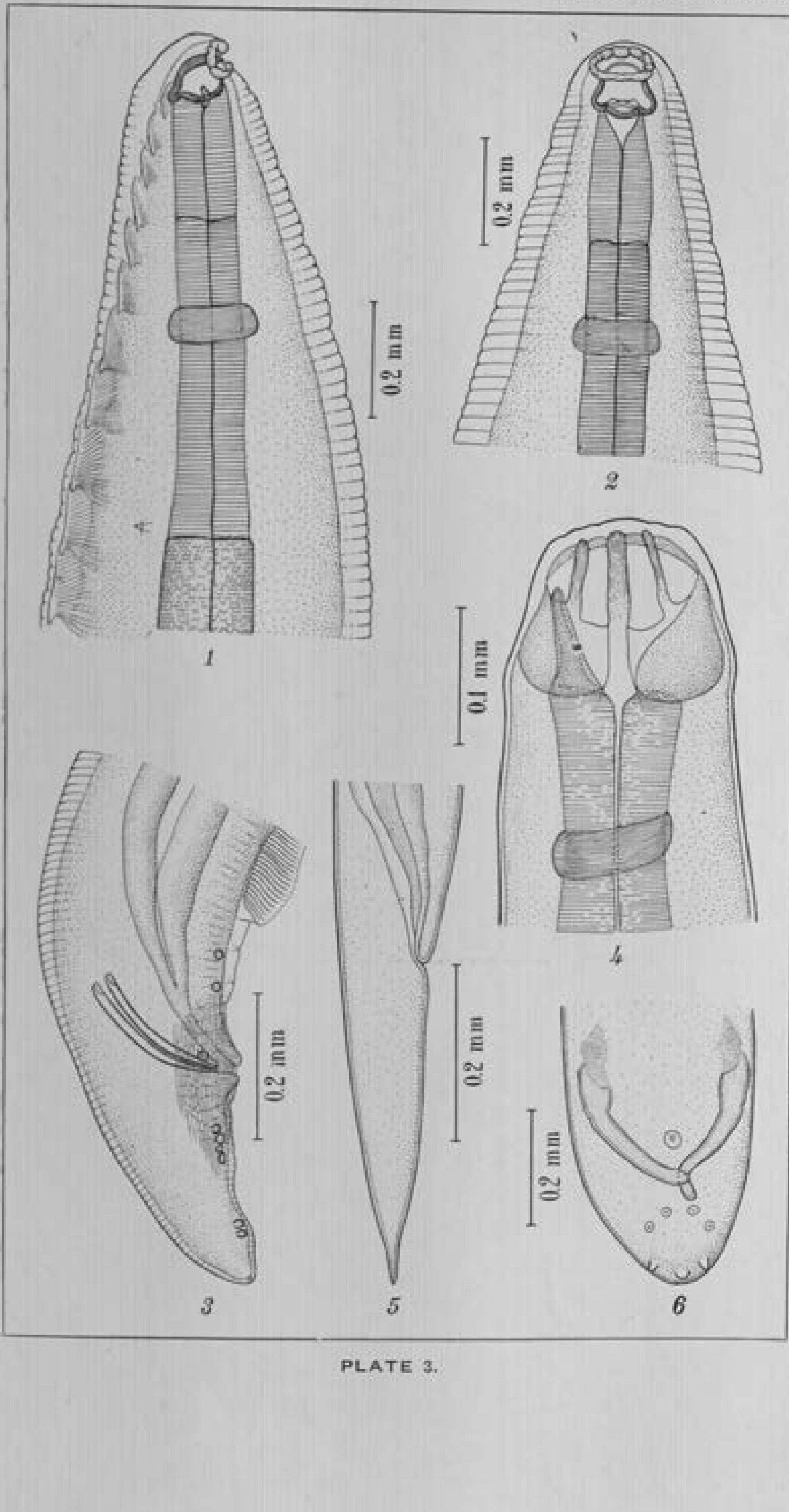

PLATE 3.

SI-SI FISHERY OF SAMAR, PHILIPPINE ISLANDS

By Santos B. Rasalan

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE AND ONE TEXT FIGURE

A great variety of marine, brackish, fresh-water, and land mollusks are known to inhabit Philippine waters. Many of them are utilized commercially, the shells for ornamental purposes and the soft parts as food. Philippine oysters are widely distributed along our shores, and their meat is in great demand, either fresh or preserved. In many places the natural supply is artificially augmented by cultivation. In the western central part of Samar, particularly along the rocky coastline of the islands within the jurisdiction of the municipalities of Catbalogan and Zumarraga, Samar Province, species of small oysters, generally known as *si-si*, are found in great abundance. Although the si-si are not cultured, the supply being furnished by nature, the fishery is an important source of livelihood for several hundred families inhabiting the province. Sampans from Leyte, Bohol, Cebu, and Masbate also sail to these places to buy si-si, either fresh or preserved. Some of the products are taken to interisland vessels which make regular calls at either Catbalogan or Zumarraga ports, and sold to the passengers. Owners of salting houses, too, send si-si to either the northern part of Luzon or to Hawaii.

Here presented are the descriptions of the several species of si-si, their habitats, the extent of the si-si fishery, methods of collection and of preservation found in towns of Catbalogan and Zumarraga, Calbayog, Santa Margarita, Gandara, and Villareal, and the islands within their jurisdiction, all in the western central part of Samar.

DESCRIPTION OF THE SPECIES

There are three known species of si-si; *si-si* proper, *Ostrea cucullata* Born; *si-si wak*, *Ostrea malabonensis* Faustino; and *pol-pol*, *Ostrea palmipes* Sowerby.[1] The last is the largest of

[1] The local name *pol-pol* may be given to any immature oyster found attached to small stones; the si-si wak is an immature oyster of larger size, attached to big boulders found far from mouths of fresh-water streams.

the three species, and is easily recognized by the shape of the shell, which is more or less rectangular with rounded corners. It is mostly found attached to stones and small rocks on protected places, and sometimes near the mouth of streams. The other two, although usually smaller, are preferred because of their delicate flavor. *Ostrea malabonensis* Faustino attaches itself singly on rocks that are more or less exposed. It usually grows larger than *O. cucullata* Born. The latter grows in mats, covering large boulders of rocks, also on exposed places.

Ostrea malabonensis Faustino.—This species is only 20 to 44 millimeters long. The shells are generally attached singly to other shells. They are oftentimes roughly triangular or irregularly oblong and solid-looking. The lower valve is deeply concave with numerous large and somewhat rounded plaitings. The upper valve is more or less flat, although at times it is also plaited at the margin. The edges of the valve next the hinge are toothed, and the interior of the shell has greenish spots.

The spawning season of this oyster begins in November and ends in March, when the oyster is fat. During this period the oysters are gathered in large numbers.

Ostrea palmipes Sowerby.—This species reaches a length of from 25 to 60 millimeters. The shell is thin, much compressed, more or less rectangular in outline, with rounded corners. The shells are generally flat, but when attached to rounded surfaces of stones and small rocks, they become more or less concave. The lower valve, which is prominently ribbed and tuberculated, extends beyond the upper valve. The latter is smaller, smooth, and only obscurely rayed.

Ostrea cucullata Born (Plate 1, figs. 1 and 2).—This si-si is the most abundant of the three species. Like in *O. malabonensis*, the shells grow singly but in mats covering the surfaces of big boulders of rocks found in places exposed to waves and far from the mouths of streams. The spawning season is from May to November of each year, when this oyster is also in season.

The shell is generally subtrigonal, solid, rather plaited, whitish toward the apex and purple toward the margin. The lower valve extends deeply beyond the flat opercular upper valve. The interior is yellowish brown with a slight purple tinge. The upper valve is brownish near the base, and purple toward the margin which is denticulated to about two-thirds from the hinge line.

The specimens on hand are apparently immature and show the effects of crowding. They range from 10 to 20 millimeters in diameter and do not show the characteristics of the species fully. This species is very closely allied to *O. malabonensis* and *O. plicata*. The lower valve of *O. cucullata* is slightly cup-shaped, with the upper valve opercular, while that of *O. malabonensis* is horsehoof-shaped. The valves of *O. plicata* are more or less uniform and strongly plaited.

DISTRIBUTION AND HABITAT

Ostrea cucullata and *O. malabonensis* are confined to between tide marks along the rocky and exposed coasts of the municipalities of Catbalogan, Zumarraga, Santa Margarita, and Villareal, and the islands belonging to them. They cover big rocks like a mat or are found on solid rocky bottoms which are completely exposed during low tide. They are not encountered near the mouths of fresh-water streams, probably because they require a higher degree of salinity of water than *Ostrea palmipes*. Natural beds of these two oysters are found in the following localities:

Santa Margarita Municipality: Libucan Islands; Catbalogan Municipality: Canahauan Islands, northern coasts of the islands of Canahauan Daco, Canahauan Guti, Batgongon, Boloang, Balading, Ani, Cambalai, Sampotan, Cagdullon, Buri, Darajuay and Majaba, the reefs Bolo, Lutao, and Waray Bancoa; as well as along the coasts of Samar between Anas and Jesus points; Zumarraga Municipality: Buad Islands—San Isidro, Tinaogan, Bioso, Tubigan, Ga-ang, Mualbual, Bublaran, and Macalunos; Dram Islands—Bagacay and Baclayon; Parasan Islands—Rizal, Parasan, and all islands and reefs along Zumarraga and Buad channels; Villareal Municipality: Talalora.

Ostrea palmipes is found only in sheltered places and near the mouths of fresh-water streams in the following places:

Calbayog Municipality: Trinidad (Sabang); Santa Margarita Municipality: Sondara Islands; Gandara Municipality: Napalisan Islands and the islands of Caparangasan and Bangon; Taranganan Municipality: Cambatutay Bay; Catbalogan Municipality: along Maulong Bay; Zumarraga Municipality: Baclayon, Bagacay, and Bontay Islands, and Burabud Bay.

METHOD OF COLLECTION

Si-si are gathered usually during low tide, when the beds are well exposed. Because the shells are attached to big boulders

and rocks, they are shucked right at the spot. An implement used for gathering is called *tete* (text fig. 1, *a*). This is a curved and chisellike pointed iron fitted with either a round wooden or a bamboo handle about 40 centimeters long. The si-si is tipped with the *tete* until the upper valve is removed, leaving the meat and lower valve on the rock. The meat is then extracted with an awl (text fig. 1, *b*) or any pointed wire, iron, or bamboo, and placed in a can or earthen jar.

Due to the small size of the oyster, one can gather only one ganta [2] at most during one low tide. Consequently few oysters are sold fresh on the markets. It takes several days to fill orders of one petroleum or gasoline can of salted si-si meat.

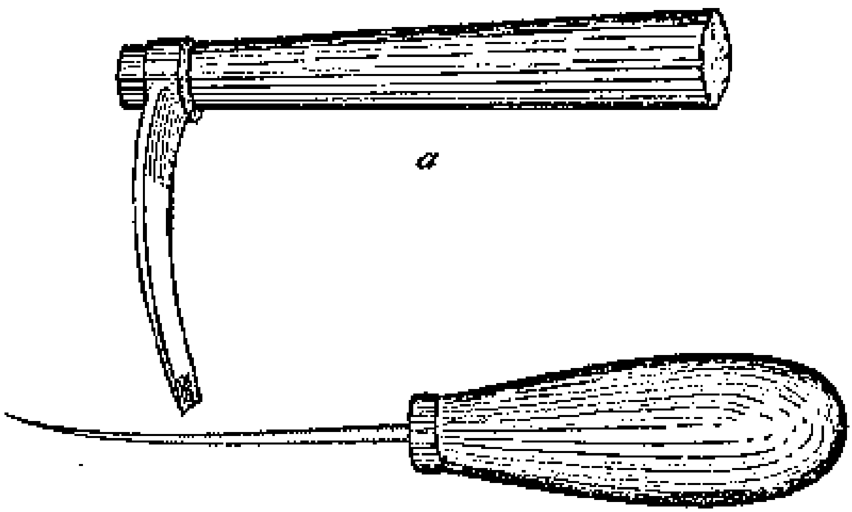

FIG. 1. *a*, Tete; *b*, awl.

It takes more time when the lowest tides occur during the night. The intervention of middlemen also has a deterring effect on the fishery. After receiving orders at a certain price a middleman goes to the gatherers and buys at a gain whatever salted si-si these have until he has bought enough to cover his orders. Sometimes he hires several gatherers, feeds them, then buys whatever amount they collect at a very low price.

UTILIZATION

Si-si are sold either fresh or preserved in the local markets. The fresh meat is usually eaten raw, with or without vinegar.

[2] 3.99 liters.

Sometimes it is pickled with vinegar seasoned with onion, salt, and pepper. Well-seasoned si-si is also made into omelet. This preparation is often served in local restaurants in the form of si-si sandwiches.

Great quantities of si-si are preserved into a form of salted product locally known as *guinamos*. After the meat is removed from the shells, it is washed well in fresh or salt water. Then it is placed in earthen jars or any receptacle and salted in the proportion of three parts si-si to one part Manila salt by volume. After this mixture is allowed to ferment for one week, it is packed in petroleum or gasoline cans and sealed. Sometimes it is placed in small bottles and sold at 10 to 15 centavos a bottle. Salted si-si from the neighboring islands are brought to the interisland vessels that make regular calls at Catbalogan port.

The Lorenzana bagoong factory buys salted si-si in great quantities and sends them to its central plant in Manila, where they are packed in 1-pound salmon cans and sealed. The process used is apparently not satisfactory, as the canned product often swells due to gas formation resulting from fermentation of the contents, and thus becomes unfit for food.

The usual proportion of three parts si-si meat to one part Manila salt is apparently not satisfactory, especially when the receptacle is not properly sealed. Molds grow on the top layer after the second week, and the contents give off a foul odor after seven weeks.

An experiment was undertaken at the Fish Preservation Station of the Bureau of Science at Catbalogan, Samar, to determine the best proportion of si-si meat to salt in the making of guinamos. The following procedure was used:

About 6 liters of si-si meat was washed in fresh water three times, after which the lot was divided into six parts, numbered 1 to 6. Each part was salted as follows:

1—One part si-si meat to one part Manila salt.
2—Two parts si-si meat to one part Manila salt.
3—Three parts si-si meat to one and one-half parts Manila salt.
4—Three parts si-si meat to one part Manila salt.
5—Four parts si-si meat to one part Manila salt.
6—Five parts si-si meat to one part Manila salt.

Each part was placed in a separate glass jar, properly covered, and labeled as bottles 1, 2, 3, 4, 5, and 6, respectively. Table 1 shows the result of the experiment.

TABLE 1.—*Result of experiment in salting si-si, undertaken at the Bureau of Science Fish Preservation Station, Catbalogan, Samar.*

Bottle.			After 1 week.		After 2 weeks.		After 3 weeks.		After 4 weeks.	
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.
1	1	1		Good	Too salty	Good	Too salty		Too salty	
2	2	1		do	do	do	Quite salty		Quite salty	
3	3	1.5	Too salty	do	Good	do	Good		Good	
4	3	1	Good	do	do	do	do		Fair	
5	4	1		do						Very foul.
6	6	1		do		Foul		Very foul.		

Bottle.			After 5 weeks.		After 6 weeks.		After 7 weeks.		After 8 weeks.	
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.
1	1	1	Too salty		Too salty		Too salty		Too salty	
2	2	1	Quite salty		Good		Good		Good	
3	3	1.5	Good		do		do		do	
4	3	1	Fair			Foul				Foul.
5	4	1								
6	5	1								

Bottle.			After 3 months.		After 4 months.		After 6 months.		Remarks.
No.	Parts si-si.	Parts salt.	Taste.	Smell.	Taste.	Smell.	Taste.	Smell.	
1	1	1	Too salty		Too salty		Too salty		
2	2	1	Good		Good		Good		
3	3	1.5	do		do		do		
4	3	1							Mold on top layer after 6 months.
5	4	1							Mold on top layer after 2 weeks. Sauce reddish after 6 weeks. Si-si thrown away after 8 weeks.
6	5	1							Mold on top layer after 1 week. Sauce brick red after 2 weeks, dull red after 3 weeks. Si-si thrown away after 4 weeks.
									Mold on top layer after 1 week. Sauce dull brick red after 2 weeks. Si-si thrown away after 3 weeks.

As can be seen from Table 1, the contents of bottles 1, 2, and 3 kept well up to the 5th month. The contents of bottle 1, however, were altogether too salty to the taste; the contents of bottle 2 were apparently sufficiently salted to prevent the growth of molds; while the contents of bottle 3, although of good flavor, developed a large amount of mold at the upper layer. The contents of bottle 4 developed molds after the first week, turned reddish at the 6th week, and emitted a foul odor after the 7th week. The contents of bottle 5 developed mold from the very first week and was thrown away after four weeks due to the foul odor; the contents of bottle 6 were thrown away after the third week for the same reason.

STATUS OF THE FISHERY

The municipalities where si-si beds are located have no regulations and exercise no control over the si-si fishery, probably because of the presence of other more important fisheries yielding larger revenues. Everyone, therefore, can gather si-si without securing a license or permit. Taking advantages of the situation, owners of salting factories, who are almost all Chinese, control the industry. The fishermen, with very few exceptions, are contracted to deliver the cleaned meat to these salters who advance money to be paid in si-si meat at a price agreed upon when the money was obtained. These salters always have the upper hand in the transaction, as the native fishermen have to dispose of their product in large quantities at prices dictated by salter.

Quite recently, however, as the demand for and the exportation of bagoong and other preserved fish products increased, Catbalogan and Zumarraga passed ordinances imposing a fee of 2 centavos for every can or box of either salted or dried fish exported. Native fishermen and gatherers have also begun to sell their raw products direct to the firms through agents sent by the latter to the fishing centers. Hence their products now command better prices.

No adequate data could be obtained on the exact value of the industry. However, it has been estimated by both municipal and provincial officials that not less than 700,000 kilos of si-si meat, worth 75,000 pesos, is gathered annually. With the apparently increasing demand from year to year, it may be expected that the value of the fishery may have also increased. At present a 5-gallon can of salted si-si is sold at a price ranging from 2.50

to 4.50 pesos, the price being highest from January to March, when the supply is low.

CONCLUSIONS AND RECOMMENDATIONS

1. The most important si-si beds are found at Catbalogan and Zumarraga and the small islands belonging to these municipalities.

2. There are three species of si-si known; namely, *Ostrea cucullata* Born, *Ostrea malabonensis* Faustino, and *Ostrea palmipes* Sowerby. The first is the most abundant, and, together with *O. malabonensis* Faustino, grows in mats over big rocks and plain rocky bottoms which are completely exposed during low tide and far from fresh-water streams. *Ostrea palmipes* grow on smaller rocks or stones in sheltered places and near the mouths of fresh-water streams.

3. Unlike other places where oysters are found, the si-si in western Samar are not cultivated in farms, and apparently no effort is being made to augment the natural supply.

4. In view of the apparently increasing demand for si-si, and the lack of a scientific method of their cultivation, it is feared that the natural supply is seriously threatened. Over-fishing is noted everywhere, especially at Waray Bancoa reefs, Darajuay Island, and Bioso, where excellent natural beds of this oyster are located. The specimens brought to the Bureau of Science are 10 to 15 millimeters long; these are usually harvested while they are still immature. *Ostrea cucullata* reaches a size of 40 to 60 millimeters.

5. Recent investigations made by the Fish and Game Administration of the Bureau of Science reveal that *O. malabonensis* Faustino and *O. palmipes* can be cultured artificially to grow larger at a rapid rate, by the use of wires and empty oyster shells. Roughley (1922) also claims that *O. cucullata* Born is being cultured with the use of stones, wood, or wire trays at George's River, New South Wales. These known methods should be studied and adapted to the conditions of the local beds. Once the best method of culture is known and applied, the supply is not only stabilized but a better quality of bigger and fatter shellfish is insured. The product can be brought fresh to distant markets, as experiments show that *Ostrea cucullata* can live two weeks out of water (Roughley, 1922); *O. malabonensis* Faustino, five days; and *O. palmipes* Sowerby, about three days (Talavera and Faustino, 1933).

6. Cleanliness in the preparation of salted si-si and during the process of fermentation is not observed. Receptacles used are not properly cleaned and salted si-si are not properly sealed and thus are easily accessible to flies and other insects.

7. The proportion of si-si meat to Manila salt must not be less than 2:1 if the product is to be kept for a period longer than 15 days.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Dorsal and ventral view of the upper valve of *Ostrea cucullata* Born.
2. A group of *Ostrea cucullata* Born, taken from a rock.

TEXT FIGURE

FIG. 1. *a*, Tete; *b*, awl.

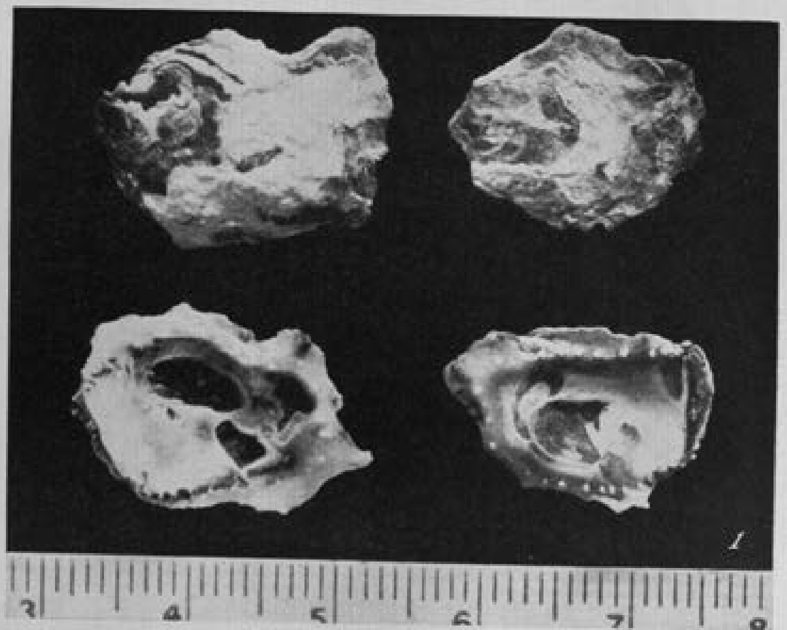

PLATE 1.

AN UNUSUAL BUD DUE TO HETEROMORPHOSIS IN ECHINASTER LUZONICUS (GRAY)[1]

By José S. Domantay

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

Budding is occasionally reported among the higher groups of animals, such as the flatworms, the annelids, and even the lower chordates. Among other animals budding is almost unknown. Regeneration is, however, very common among all animals. It usually takes place after fission or after autotomy. Autotomy is common among the higher animals, as some echinoderms, annelids, and arthropods, although it is apparently unknown among the highest group of animals. Regeneration following fission or autotomy among lower animals is very remarkable in restoring entirely the lost part of the organism. Among the vertebrates, however, where autotomy is apparently unknown, regeneration is confined to the healing of the cut part or wound.

Among the Echinodermata autotomy is known in ophiuroids, holothurians, and crinoids. In the ophiuroids and crinoids it is manifested in the breaking or snapping off of arms when the animal is caught, in order to escape from an enemy. Among holothurians preyed upon or disturbed by an enemy, however, it is manifested in the throwing off of the internal organs. All the lost parts of the body are restored after some time by reconstitution. Among the asteroids and echinoids autotomy is apparently not known, although regeneration or reconstitution is the prevailing phenomenon. It has been reported that when a single starfish is cut into many small pieces and thrown back into the sea, each piece regenerates into a complete animal. This is a case of reconstitution in the stricter sense of the word.

This report is corroborated by my findings in Puerto Galera Marine Biological Station in *Echinaster luzonicus* (Gray), the single arm or portion of an arm of which often regenerates into a complete animal.

[1] Read before the Fourth Philippine Science Convention, Manila, February 24, 1937.

The bud is found on the abactinal side of the body (Plate 1, fig. 3). In my specimen the bud occurred between the base of one arm of the trivium and the centrodorsal disc. It has four rays, while the mother starfish has six. This abnormal budding may be explained physiologically as reconstitution, or heteromorphosis. According to findings in *Euplanaria* (*Planaria*) by Child, Sivickis, and others, the capability for regeneration along the main axis of the body corresponds to the axial metabolic gradients in the body of the individual. It is, therefore, presumed that in the body of any organism the metabolic rate is higher in the head region where the nerve center or brain is located. In a radiate organism, like the starfish, where there is no cephalization, there is no corresponding centralization of sense organs, hence the metabolic rate is almost the same all over except possibly along the nerve pentagon (nerve ring) of the epidermal and the deep nervous system, which are found within the body and along the radii of the arms. This accounts for the complete regeneration of any injured part in the neighborhood of the nerve ring and the radial nerves. In this same species, when a single arm is cut off from the body, the cut end, which is the proximal end, usually regenerates into a complete animal, forming a comet-shaped individual (Plate 1, figs. 4 to 6). Also, the ray from where the cut arm has been removed regenerates into a fully developed arm. A *Linckia multifora* with one intact arm producing a comet-shaped ray by budding has been reported by Richard Hertwig in 1924, which indicates the absence of a distinct highly metabolic region in the starfish. The entire disc or body, together with the radii of the starfish, may correspond to the cephalic region of those axial animals with distinct head, hence there is slight differentiation in this region, so that when the animal is injured at any point along these regions the tendency of the injured part is to regenerate into a complete miniature individual, forming a bud. The question may be asked, why in *Echinaster luzonicus* is there not a single case of an entire individual with a cut arm regenerating into a complete or comet-shaped ray as has been reported of *Linckia multifora?* This phenomenon may be a species specific in nature. In *E. luzonicus* the comet form is always produced at the proximal part of the ray and not at the distal end, as in *Linckia multifora*.

From the embryological and physiological point of view this unusual budding may be explained by the conjoining of auto-

site and parasite twins, the mother starfish being the autosite and the bud the parasite. The lateral budding theory of the origin of conjoined twins may also explain this unusual bud. The bud may be compared to a condition found in certain plants with a terminal growing point. When the normal rate of growth at the growing point is not disturbed, the secondary buds are inhibited; but when the primary bud is injured, the secondary buds arise and grow, although they are often partially inhibited by the presence of the primary bud, and are therefore very much smaller than the latter.

ACKNOWLEDGMENT

The writer is indebted to Dr. Felix V. Santos, of the Department of Zoölogy, University of the Philippines, for constructive suggestions, and to Dr. Leopoldo S. Clemente, acting head of the same Department, for going over this paper.

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ILLUSTRATION

PLATE 1

FIG. 1. *Echinaster purpureus* Savigny, aboral view, with all the arms showing a sign of regeneration; × 0.5.

2. Oral view of the individual illustrated in fig. 1; × 0.5.
3. *Echinaster luzonicus* (Gray), aboral view of an individual with a bud connected abactinally; × 1.
4. *Echinaster luzonicus* (Gray), aboral view of one arm regenerating into a complete comet-shaped individual; × 1.
5. Oral view of the individual illustrated in fig. 4; × 1.
6. *Echinaster luzonicus* (Gray), aboral view of another comet-shaped individual. In both cases the regenerating disc and rays come from the proximal end of the arm; × 1.

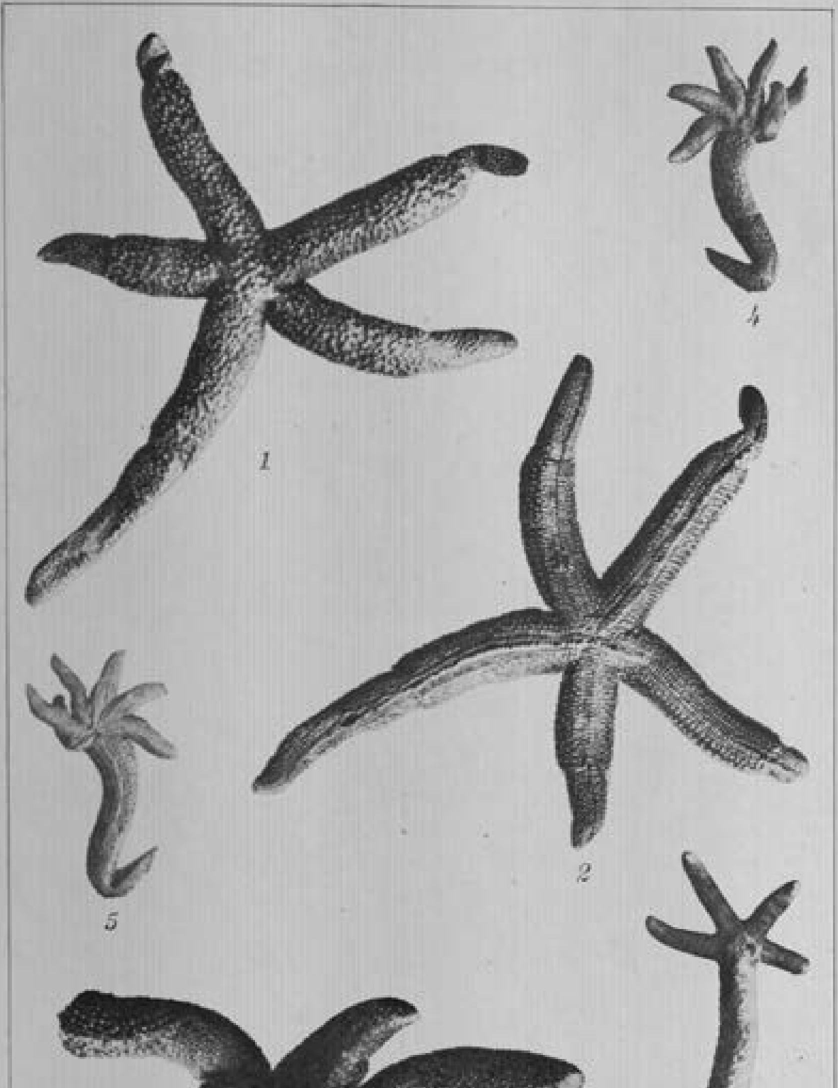

PLATE 1.

DIATOMS FROM THE PHILIPPINES, I

DIATOMS FROM DRINKING WATER, BALARA, RIZAL PROVINCE

By B. W. Skvortzow

Of Harbin, Manchoukuo

TWO PLATES

In 1936 Dr. Eduardo Quisumbing, curator of the Philippine National Herbarium, Manila, kindly sent me some diatom material collected by him in the Philippine Islands. The results of the identification of these diatoms will be published in a series of articles. The present note is the first of this series, and is based on a sample collected January 29, 1936, from filter No. 8 in Balara, Rizal Province. The brownish mucilaginous mass contained a great number of living diatoms of 42 different epiphytic forms, *Rhopalodia gibberula* var. *Heurckii* and *Rhopalodia Quisumbingiana* sp. nov. predominating. Almost all were fresh-water species, except *Rhopalodia gibberula* var. *van Heurckii* and *Nitzschia Clausii*, typical brackish-water species of which the former was abundant. *Rhopalodia Quisumbingiana* sp. nov. is probably also a brackish-water species. Almost all Balara diatoms were of a cosmopolitan nature, except several tropical species, as *Cymbella bengalensis* Grun., *Cymbella turgidula* Grun., *Surirella bengalensis* Grun., and *Cocconeis placentula* var. *euglypta*. The new species and varieties described here as new are *Achnanthes philippinica* sp. nov., *Navicula Hustedtii* Krasske fo. *philippina* fo. nov., *Navicula philippina* sp. nov., *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov., *Rhopalodia Quisumbingiana* sp. nov., *Nitzschia philippina* sp. nov., *Nitzschia philippina* sp. nov., *Nitzschia flexa* Schumann var. *philippina* var. nov. All the species and forms I have found are figured, and of new forms the Latin diagnoses are given. The diagrams were made by me with E. Leitz Apochromat 2 mm and Compens Ocular No. 4.

MELOSIRA VARIANS C. A. Agardh. Plate I, fig. 36.

> *Melosira varians* C. A. Agardh, FR. HUSTEDT, Bacillar. (1930) 85, 86, fig. 41.

Valve cylindrical, with smooth membrane. Height of valve 0.0255 mm; breadth, 0.017. Infrequent. Reported from fresh water.

CYMBELLA STELLIGERA Cleve and Grun. Plate 1, fig. 34.

Cymbella stelligera Cleve and Grun., FR. HUSTEDT, Bacillar. (1930) 100, fig. 65.

Valve circular, with radiating marginal striæ 15 in 0.01 mm. Central area with striæ forming a star. Diameter of the valve 0.011 mm. Common. A fresh-water species reported from littoral zones of lakes.

FRAGILARIA CROTONENSIS Kitton. Plate 1, fig. 9.

Fragilaria crotonensis Kitton, FR. HUSTEDT, Bacillar. (1930) 137, 138, fig. 125.

Valve linear-lanceolate, constricted from both sides in the middle part and gradually tapering to capitate ends. Length, 0.085 mm; breadth, 0.002. Striæ 15 to 18 in 0.01 mm. Infrequent. Reported from fresh-water lakes.

SYNEDRA ULNA (Nitzsch) Ehr. Plate 1, figs. 6 and 7; Plate 2, fig. 6.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 151, 152, figs. 158, 159.

Valve linear, with subrostrate ends, or lanceolate, gradually tapering toward the acute ends. Length, 0.088 to 0.144 mm; breadth, 0.0055 to 0.0068. Striæ 8 to 10 in 0.01 mm. Common. A fresh-water species.

SYNEDRA ULNA (Nitzsch) Ehr. var. **AEQUALIS** (Kütz.) Hustedt. Plate 2, fig. 1.

Synedra ulna (Nitzsch) Ehr. var. *aequalis* (Kütz.) FR. HUSTEDT, Bacillar. (1930) 152, fig. 164.

Valve very long, linear with broad rounded ends. Striæ not interrupted in the center by a vacant space. Length, 357 mm; breadth, 0.0068. Striæ 9 in 0.01 mm. Common. A fresh-water diatom.

SYNEDRA ACUS Kütz. var. **RADIANS** (Kütz.) Hustedt. Plate 2, fig. 2.

Synedra acus Kütz. var. *radians* (Kütz.) FR. HUSTEDT, Bacillar. (1930) 155, fig. 171.

Frustule very long, linear, almost imperceptibly attenuated towards the ends. Ends rounded. Central quadrangular space distinct. Length, 0.137 mm; breadth, 0.0025 at the middle, 0.0017 at the ends. Striæ fine, about 15 in 0.01 mm. Common. Reported from littoral zones of fresh-water lakes.

COCCONEIS PLACENTULA Ehr. var. **EUGLYPTA** (Ehr.) Cleve. Plate 1, figs. 35, 37, 43.

Cocconeis placentula Ehr. var. *euglypta* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 261; VAN HEURCK, Synopsis (1880) pl. 30, figs. 33, 34.

Valve broad-elliptic, with rounded ends. Length, 0.0085 to 0.025 mm; breadth, 0.0031 to 0.013. Upper valve crossed by 3 to 5 longitudinal, blank bands. Striæ 20 to 24 in 0.01 mm. Common. Var. *euglypta* is widely distributed in tropical regions. A fresh-water diatom.

ACHNANTHES MINUTISSIMA Kütz. Plate 1, fig. 4.

Achnanthes minutissima Kütz., FR. HUSTEDT, Bacillar. (1930) 198, fig. 274.

Valve linear-elliptic, with attenuate-rounded ends. Upper valve with linear filiform axial and central areas. Lower valve with very small suborbicular central area. Length, 0.12 mm; breadth, 0.0023. Striæ very fine, indistinct. Common. A fresh-water diatom.

ACHNANTHES MINUTISSIMA Kütz. var. CRYPTOCEPHALA Grun. Plate 1, figs. 11 and 12.

Achnanthes minutissima Kütz. var. *cryptocephala* Grun., FR. HUSTEDT, Bacillar. (1930) 198, fig. 275.

Differs from the type in its broader middle part and attenuate subcapitate ends. Length, 0.012 mm; breadth, 0.002 to 0.0022. Striæ indistinct. Common.

ACHNANTHES LANCEOLATA Bréb. var. ROSTRATA Hust. Plate 1, fig. 24.

Achnanthes lanceolata Bréb. var. *rostrata* FR. HUSTEDT, Bacillar. (1930) 208, fig. 306b.

Valve elliptic, with rostrate rounded ends. Upper valve with linear central and axial areas with a horse-shoe-shaped area on one side in the middle of valve. Lower valve with slightly dilated central area and subradiate striæ. Length, 0.0136 mm; breadth, 0.0051. Striæ 12 in 0.01 mm. Infrequent. A fresh-water diatom.

ACHNANTHES HAUCKIANA Grun. var. NIPPONICA Skv.? Plate 1, fig. 23.

Achnanthes Hauckiana Grun. var. *nipponica* SKVORTZOW, Diatoms from Biwa Lake, Honshu Island, Nippon (1936) pl. 6, fig. 12.

Valve broad-elliptic, with slightly attenuate, broad-rounded ends. Upper and lower valves with narrow linear central and axial areas. Length, 0.012 mm; breadth, 0.0034. Striæ radiate, 14 in 0.01 mm. Infrequent. Reported from Biwa Lake, Nippon.

ACHNANTHES PHILIPPINICA sp. nov. Plate 1, fig. 29.

Valvis ellipticis-attenuatis, cum polis rotundatis. Valva superior area axilares et centralis angusta linearis. Valva inferior raphe directa. Area axialli angustissima; area centrali transversaliter angustissima dilatata. Longis valvis 0.01 mm;

latis valvis 0.0025. Striæ circiter 30 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. Quisumbing.

Valve elongate-elliptic, slightly attenuate, broad-rounded. Length, 0.01 mm; breadth, 0.0025. Upper valve with filiform central and axial areas. Lower valve with narrow linear axial area. Central area a short transverse fascia. Striæ very fine, parallel, about 30 in 0.01 mm. Infrequent. A species with the outline of *Achnanthes linearis* W. Smith.

DIPLONEIS OVALIS (Hilse) Cleve forma. Plate 1, fig. 46.

Diploneis ovalis (Hilse) Cleve, FR. HUSTEDT, Bacillar. (1930) 249, fig. 390.

Valve elliptic, with broad ends. Central nodule quadrate. Median line straight. Furrows narrow, closely following the central node. Structure-transverse rows of radiate distinct alveoli, 12 in 0.01 mm. Length, 0.029 mm; breadth, 0.014. Rare. The type has a broader central nodule. A fresh-water species.

DIPLONEIS PUELLA (Schumann) Cleve. Plate 1, fig. 72.

Diploneis puella (Schumann) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 394.

Valve broad-elliptic with short, broad-rounded ends. Length, 0.0187 mm; breadth, 0.012. Central nodule quadrate, small; furrows very narrow, closely following the central nodule. Striæ radiate, 15 in 0.01 mm, with indistinct alveoli. Infrequent. Reported from fresh and brackish water.

STAURONEIS ANCEPS Ehr. Plate 2, fig. 6.

Stauroneis anceps Ehr., FR. HUSTEDT, Bacillar. (1930) 256, fig. 405.

Valve elliptic, gradually tapering from the middle to the subrostrate, acute ends. Length, 0.037 mm; breadth, 0.009. Striæ slightly radiate, more distinct in the middle part, in the middle about 20, at the ends, about 25, in 0.01 mm. Rare. A fresh-water diatom.

Genus NAVICULA Bory

NAVICULÆ MESOLEIÆ CLEVE

NAVICULA HUSTEDTII Krasske fo. **PHILIPPINA** fo. nov. Plate 1, fig. 44.

Differt a typo striis robustris. Longis valvis 0.0153 mm; latis 0.0051. Striæ 20 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve elliptic-lanceolate, with attenuate capitate ends. Length, 0.0153 mm; breadth, 0.0051. Axial area narrow linear; central broad and suborbicular. Striæ slightly radiate, 20 in 0.01 mm. Infrequent. Differs from the type in more robust striæ. The type is known from Europe in marshy waters.

NAVICULÆ ENTOLEIÆ CLEVE

NAVICULA CONTENTA Grun. fo. **BICEPS** Arnott. Plate 1, fig. 40.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458c.

Valve linear, constricted from both sides. Ends broad and subcapitate. Length, 0.01 mm; bread, 0.0034. Striæ very fine and indistinct. Infrequent. Reported from mountain districts on moist stones and in mosses.

NAVICULÆ MINUSCULÆ CLEVE

NAVICULA MINUSCULA Grun. Plate 1, fig. 41.

Navicula minuscula Grun., FR. HUSTEDT, Bacillar. (1930) 288, fig. 483.

Valve elliptic-lanceolate, with attenuate and subrostrate ends. Length, 0.011 mm; breadth, 0.0042. Striæ radiate, 18 in 0.01 mm. Differs from the type in the more robust striæ. Rare. Reported from fresh water and moist soil.

NAVICULÆ LINEOLATÆ CLEVE

NAVICULA CRYPTOCEPHALA Kütz. Plate 2, fig. 5.

Navicula cryptocephala Kütz., FR. HUSTEDT, Bacillar. (1930) 295, fig. 496.

Valve lanceolate, with attenuate, slightly subcapitate ends. Length, 0.024 mm; breadth, 0.0042. Striæ radiate, 18 to 20 in 0.01 mm. Infrequent. Reported from fresh and brackish water.

NAVICULA PHILIPPINA sp. nov. Plate 1, figs. 25 and 45.

Valvis lanceolatis cum polis subacutis. Area axilaris anguste lineatis; centralis modice dilatate. Raphe directa. Striis radiantes, 10 ad 14 in 0.01 mm, non convergentibus. Longis valvis 0.0204 ad 0.0255 mm; latis 0.005. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve lanceolate, gradually tapering from the middle to the acute ends. Length, 0.0204 to 0.0255 mm; breadth, 0.005. Axial area narrow, linear; central subordicular. Raphe straight. Striæ radiate, 10 to 11 in 0.01 mm. Infrequent. Akin to *Navicula simplex* Krasske.

NAVICULA MENISCULUS Schumann. Plate 2, fig. 8.

Navicula menisculus Schumann, FR. HUSTEDT, Bacillar. (1930) 301, fig. 517.

Valve elliptic-lanceolate with attenuate acute ends. Length, 0.0153 mm; breadth, 0.005. Axial area narrow, central suborbicular. Striæ radiate, divergent in the middle and slightly convergent at the ends, 12 to 14 in 0.01 mm and not lineolate. Rare. Reported from fresh and brackish water.

PINNULARIA MESOLEPTA (Ehr.) W. Smith. Plate 1, fig. 14.

Pinnularia mesolepta (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 319, fig. 575*a*.

Valve linear, triundulate with capitate ends. Length, 0.0629 mm; breadth, 0.01. Striæ radiate, divergent in the middle and convergent at the ends, 9 in 0.01 mm. Central area a broad fascia. Rare. Reported from fresh water.

CYMBELLA BENGALENSIS Grun. Plate 2, fig. 1.

Cymbella bengalensis Grun., A. SCHMIDT. Atlas Diatom. (1875–1931) pl. 9, figs. 12, 13; pl. 71, fig. 29; pl. 375, fig. 3.

Cymbella aspera Ehr. var. *bengalensis* Grun., CLEVE, Synopsis of the Naviculoid Diatoms (1894) 1, 176.

Valve boat-shaped, with strongly arcuate dorsal margin and centrally gibbous ventral margin. Ends obtuse, rounded. Length, 0.093 to 0.105 mm; breadth, 0.00255 to 0.027. Striæ ventral 10 to 11, dorsal 8 in 0.01 mm. Puncta 14 to 16 in 0.01 mm. Median line slightly arcuate. Axial area linear, scarcely dilated around the central nodule. Infrequent. Reported from Bengal and Sacotra.

CYMBELLA TURGIDULA Grun. Plate 2, fig. 11.

Cymbella turgidula Grun., FR. HUSTEDT, Bacillar. (1930) 362, fig. 670; A. SCHMIDT. Atlas Diatom. (1931) pl. 376, figs. 8–13.

Valve asymmetrical, boat-shaped, arcuate at dorsal and slightly convex at ventral margins. Ends subrostrate. Length, 0.0391 mm; breadth, 0.011. Striæ ventral 7, dorsal 8 in 0.01 mm. At the ventral side of the central nodule are two small puncta, ending the median striæ. Infrequent. Common in tropical districts.

CYMBELLA VENTRICOSA Kütz. Plate 1, figs. 21, 38, 39, and 42.

Cymbella ventricosa Kütz., FR. HUSTEDT, Bacillar. (1930) 359, fig. 661.

Valve boat-shaped, asymmetrical with acute dorsal and moderately convex ventral margins. Median line about straight. Axial and central area very narrow. Striæ radiate, ventral and

dorsal 12 in 0.01 mm. Length, 0.012 to 0.015 mm; breadth, 0.034 to 0.042. Very common. A fresh-water species.

GOMPHONEMA LANCEOLATUM Ehr. Plate 1, fig. 31; Plate 2, fig. 12.

Gomphonema lanceolatum Ehr. FR. HUSTEDT, Bacillar. (1930) 376, fig. 700.

Valve lanceolate, clavate, with the apex broader than the basis. Length, 0.0238 to 0.0425 mm; breadth, 0.0062 to 0.0085. Striæ radiate, 9 to 11 in 0.01 mm. Infrequent. A fresh-water diatom.

EPITHEMIA SOREX Kütz. Plate 1, fig. 15.

Epithemia sorex Kütz., FR. HUSTEDT, Bacillar. (1930) 388, fig. 736.

Valve lunate, with arcuate dorsal and constricted ventral margins. Ends attenuate and capitate. Length, 0.0476 mm; breadth, 0.0119. Costæ 5, striæ 12 in 0.01 mm. Rare. Reported from fresh water.

EPITHEMIA ZEBRA (Ehr.) Kütz. Plate 1, fig. 13; Plate 2, figs. 10 and 16.

Epithemia zebra (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 384, 385, fig. 729.

Valve lunate, arcuate. Ventral part slightly constricted and the ends moderately attenuate and rounded. Length, 0.0357 to 0.056 mm; breadth, 0.0085 to 0.013. Costæ 2 to 4, rows of granules 8 to 10 in 0.01 mm. Infrequent. Reported from fresh water.

RHOPALODIA GIBBA (Ehr.) O. Müll. Plate 1, fig. 26.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 740.

Valve from the front view sublanceolate, slightly arcuate and reflexed on the dorsal and straight on the ventral margins. Length, 0.076 mm; breadth, 0.019. Costæ 7, striæ 14 in 0.01 mm. Common. A fresh-water diatom.

RHOPALODIA GIBBA (Ehr.) O. Müll. var. VENTRICOSA (Ehr.) Grun. Plate 1, fig. 17.

Rhopalodia gibba (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 391, fig. 741.

Valve from the front view sublanceolate, with arcuate and reflexed dorsal margin and attenuate reflexed ends. Ventral side straight. Length, 0.055 mm; breadth, 0.022. Costæ 8, striæ 16 in 0.01 mm. Infrequent. Common in fresh water.

RHOPALODIA GIBBA (Ehr.) O. Müll. var. PHILIPPINICA var. nov. Plate 1, figs. 16 and 20; Plate 2, fig. 17.

Differt a typo valvis dorsale triundulatis. Longis valvis 0.098 ad 0.115 mm; latis 0.022 ad 0.024. Costæ 6 ad 7, striis

12 ad 14 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve from front view linear and triundulate. Ventral side straight. Length, 0.098 to 0.115 mm; breadth, 0.022 to 0.024. End breadth, 0.013 mm. Costæ 6 to 7, striæ 12 to 14 in 0.01 mm. Differs from the type in its triundulate dorsal margin. Infrequent.

RHOPALODIA GIBBERULA (Ehr.) O. Müll. var. VAN HEURCKII O. Müll. Plate 1, figs. 27, 29, and 30.

Rhopalodia gibberula (Ehr.) O. Müll. var. *van Heurckii* O. Müll., A. SCHMIDT, Atlas Diatom. (1905) pl. 255, figs. 13, 15, 21.

Valve from the front view moon-shaped, arcuate at dorsal margin, and straight at ventral. Ends reflexed. Length, 0.01 to 0.0306 mm; breadth, 0.018 to 0.0204. Costæ slightly radiate, 2 to 3, striæ 12 in 0.01 mm, punctate. Puncta 12 to 13 in 0.01 mm. Abundant. A brackish-water diatom.

RHOPALODIA QUISUMBINGIANA sp. nov. Plate 1, figs. 1 to 4; Plate 2, figs. 13 and 14.

Frustolis elongate-elliptisis, modice spiralis, cum polis subacutis, rotundatis.

Valvis linaribus modice lunatis et inflexis; dorso tumidis ad medium interruptis; ventre directis. Costæ ad medium valvis parallelis, ad polis radiantes, 5 ad 7; striis 14 ad 15 in 0.01 mm, ad marginem ventre cum series punctorum minoris ornata. Longis valvis 0.047 ad 0.127 mm; latis 0.018 ad 0.022. Costæ 5 ad 7; striis 14 ad 15 in 0.01 mm. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Frustule from the front view elongate-elliptic, asymmetrical, slightly and distinctly spirally curved, with one end slightly broader than the other.

Valve lunate, slightly reflexed at the extremities, with long curved ends and small single dots on the median marginal interruption. Ventral side almost straight, punctate along the margin. Costæ and striæ parallel on the middle, radiate at both ends. Length, 0.047 to 0.1275 mm; breadth, 0.018 to 0.025. Costæ 5 to 7, striæ 14 to 15 in 0.01 mm. Common. Differs from *Rhopalodia parallela* (Grun) O. Müll. in the more ovoid frustules and the spiral curve, and from *Rhopalodia gracilis* O. Müll., a species reported from western Africa, in the curved valves and in the presence of a median marginal interruption with a dot. Named in honor of Dr. E. Quisumbing, curator, Philippine National Herbarium, Manila, Philippines.

NITZSCHIA GRACILIS Hantzsch. Plate 1, fig. 9; Plate 2, fig. 4.

Nitzschia gracilis Hantzsch, A. SCHMIDT, Atlas Diatom. (1924) pl. 349, figs. 35, 37.

Valve linear-filiform, gradually tapering from the middle to the apiculate ends. Length, 0.0306 to 0.0357 mm; breadth, 0.0017 to 0.002. Costæ 12 to 15 in 0.01 mm. Striæ very fine, indistinct. Common. A fresh-water diatom.

NITZSCHIA PHILIPPINA sp. nov. Plate 1, fig. 32.

Valvis angustis-linearibus, ad marginem parallelis, cum polis subacutis, rotundatis. Punctis carinalibus minimus, 10 ad 11 in 0.01 mm. Striis delicatis, inconspicuis. Longis valvis 0.091 mm; latis 0.0034. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve linear or linear-lanceolate, with parallel margins and slightly attenuate and acute ends. Length, 0.0918 mm; breadth, 0.0034. Costæ 10 to 11 in 0.01 mm. Striæ very fine and indistinct. Infrequent. A species of the outline of *Nitzchia frustulum* (Kütz.) Grun. but with indistinct striæ. The related species are *Nitzschia subtilis* (Kütz.) Grun. and *Nitzchia Nikitiana* sp. nov. from northern Manchuria.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, figs. 19 and 33.

Nitzschia palea (Kütz.) W. Smith, A. SCHMIDT, Atlas Diatom. (1924) pl. 349, figs. 1–10.

Valve linear-lanceolate, parallel in the middle part and attenuate acute at the ends. Length, 0.0255 to 0.0272 mm; breadth, 0.0032 to 0.0034. Costæ 12 in 0.01 mm. Striæ indistinct. Common. A fresh-water diatom.

NITZCHIA FLEXA Schumann var. PHILIPPINICA var. nov. Plate 1, fig. 47.

Valvis gracilioribus, minoribus et brevioribus quam species. Longis valvis 0.04 ad 0.0425 mm; latis 0.0017 ad 0.0019. Costæ 12. Striis inconspicuis. Habit. in aquis dulcis prope Balara, Rizal Province, Philippine Insul. Legit Dr. E. Quisumbing.

Valve front view linear, sigmoid, with parallel margins. Length, 0.04 to 0.0425 mm; breath, 0.0017 to 0.0019. Costæ 12 in 0.01 mm. Infrequent. Smaller and shorter than the type. *Nitzschia flexa* is reported from fresh waters of Europe.

NITZSCHIA SIGMOIDEA (Ehr.) W. Smith? Plate 2, fig. 7.

Nitzschia sigmoidea (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 419, fig. 810.

Valve front view linear-sigmoid, with slightly attenuate and obtuse ends. Length, 0.14 mm; breadth, 0.008. Costæ 7, striæ about 25 to 0.01 mm. Rare. A fresh-water species.

NITZSCHIA CLAUSII Hantzsch. Plate 1, fig. 14.

Nitzschia Clausii Hantzsch, FR. HUSTEDT, Bacillar. (1930) 421, fig. 814; A. SCHMIDT, Atlas Diatom. (1921) pl. 336, figs. 7–11.

Valve linear-lanceolate, with sigmoid ends. Margin parallel. Ends attenuate and slightly capitate. Length, 0.0425 mm; breadth, 0.0034. Costæ 0 in 0.01 mm. Striæ very fine, indistinct. Infrequent. A brackish-water diatom.

NITZSCHIA ACICULARIS W. Smith. Plate 1, fig. 10.

Nitzschia acicularis W. Smith, FR. HUSTEDT, Bacillar. (1930) 423, fig. 821; A. SCHMIDT, Atlas Diatom. (1921) pl. 335, figs. 15–17.

Valve linear-lanceolate, with almost parallel margins and attenuate, long, filiform ends. Length, 0.076 mm; breadth, 0.0034. Costæ 16 to 17 in 0.01 mm. Striæ also indistinct. Infrequent. Reported from fresh water.

SURIRELLA BENGALENSIS Grun. Plate 2, fig. 16.

Surirella bengalensis Grun., A. SCHMIDT, Atlas Diatom. (1875) pl. 24, fig. 16; MEISTER, Beiträge zur Bacillar. Japans 11 (1914) 229, pl. 8, figs. 11–13; SKVORTZOW, Diatoms from Chengtu, Szechwan, Western China, pl. 3, fig. 20.

Valve broad-ovate, with distinct, broad outer rim and costæ not reaching the pseudoraphe. Marginal keel forming wings. Length, 0.076 mm; breadth, 0.039. Costæ 3 in 0.01 mm. Infrequent. Reported from Bengal, India, from Tokyo, Nippon, and recently from Chengtu, Western China.

SURIRELLA CAPRONII Breb. Plate 2, fig. 15.

Surirella Capronii Breb., FR. HUSTEDT, Bacillar. (1930) 440, fig. 867.

Valve narrow-ovate, with one end much broader than the other. Marginal keel forming wings or alæ seen in zone view. Costæ distinct, about reaching the pseudoraphe. Central area linear and smooth. Two distinct spines near each end. Length, 0.047 to 0.17 mm; breadth, 0.017 to 0.056 mm. Costæ 2 to 4 in 0.01 mm. Common. Reported from fresh water.

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ILLUSTRATIONS

PLATE 1

FIGS. 1 to 4. *Rhopalodia Quisumbingiana* sp. nov.
FIG. 5. *Achnanthes minutissima* Kütz.
FIGS. 6 and 7. *Synedra ulna* (Nitzsch) Ehr.
FIG. 8. *Nitzschia gracilis* Hantzsch.
9. *Fragilaria crotonensis* Kitton.
10. *Nitzschia acicularis* W. Smith.
FIGS. 11 and 12. *Achnanthes minutissima* Kütz. var. *cryptocephala* Grun.
FIG. 13. *Epithemia zebra* (Ehr.) Kütz.
14. *Pinnularia mesolepta* (Ehr.) W. Smith.
15. *Epithemia sorex* Kütz.
16. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
17. *Rhopalodia gibba* (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun.
18. *Nitzschia Clausii* Hantzsch.
19. *Nitzschia palea* (Kütz.) W. Smith.
20. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
21. *Cymbella ventricosa* Kütz.
22. *Diploneis puella* (Schum.) Cleve.
23. *Achnanthes Hauckiana* Grun. var. *nipponica* Skv.?
24. *Achnanthes lanceolata* Bréb. var. *rostrata* Hust.
25. *Navicula philippina* sp. nov.
26. *Rhopalodia gibba* (Ehr.) O. Müll.
27. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *van Heurckii* O. Müll.
28. *Achnanthes philippinica* sp. nov.
FIGS. 29 and 30. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *van Heurckii* O. Müll.
FIG. 31. *Gomphonema lanceolatum* Ehr.
32. *Nitzschia philippina* sp. nov.
33. *Nitzschia palea* (Kütz.) W. Smith.
34. *Melosira varians* C. A. Ag.
35. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
36. *Cymbella stelligera* Cleve and Grun.
37. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
FIGS. 38 and 39. *Cymbella ventricosa* Kütz.
FIG. 40. *Navicula contenta* Grun. fo. *biceps* Arnott.
41. *Navicula minuscula* Grun.
42. *Cymbella ventricosa* Kütz.
43. *Cocconeis placentula* Ehr. var. *euglypta* (Ehr.) Cleve.
44. *Navicula Hustedtii* Krasske fo. *philippina* fo. nov.
45. *Navicula philippina* sp. nov.
46. *Diploneis ovalis* (Hilse) Cleve.
47. *Nitzschia flexa* Schum. var. *philippinica* var. nov.

PLATE 2

FIG. 1. *Synedra ulna* (Nitsch) Ehr. var. *aequalis* (Kütz.) Hust.
2. *Synedra acus* Kütz. var. *radians* (Kütz.) Hust.
3. *Navicula cryptocephala* Kütz.
4. *Synedra ulna* (Nitzsch) Ehr.
5. *Nitzschia gracilis* Hantzsch.
6. *Stauroneis anceps* Ehr.
7. *Nitzschia sigmoidea* (Ehr.) W. Smith?
8. *Navicula menisculus* Schum.
9. *Cymbella bengalensis* Grun.
10. *Epithemia zebra* (Ehr.) Kütz.
11. *Cymbella turgidula* Grun.
12. *Gomphonema lanceolatum* Ehr.

FIGS. 13 and 14. *Rhopalodia Quisumbingiana* sp. nov.

FIG. 15. *Surirella Capronii* Breb.
16. *Epithemia zebra* (Ehr.) Kütz.
17. *Rhopalodia gibba* (Ehr.) O. Müll. var. *philippinica* var. nov.
18. *Surirella bengalensis* Grun.

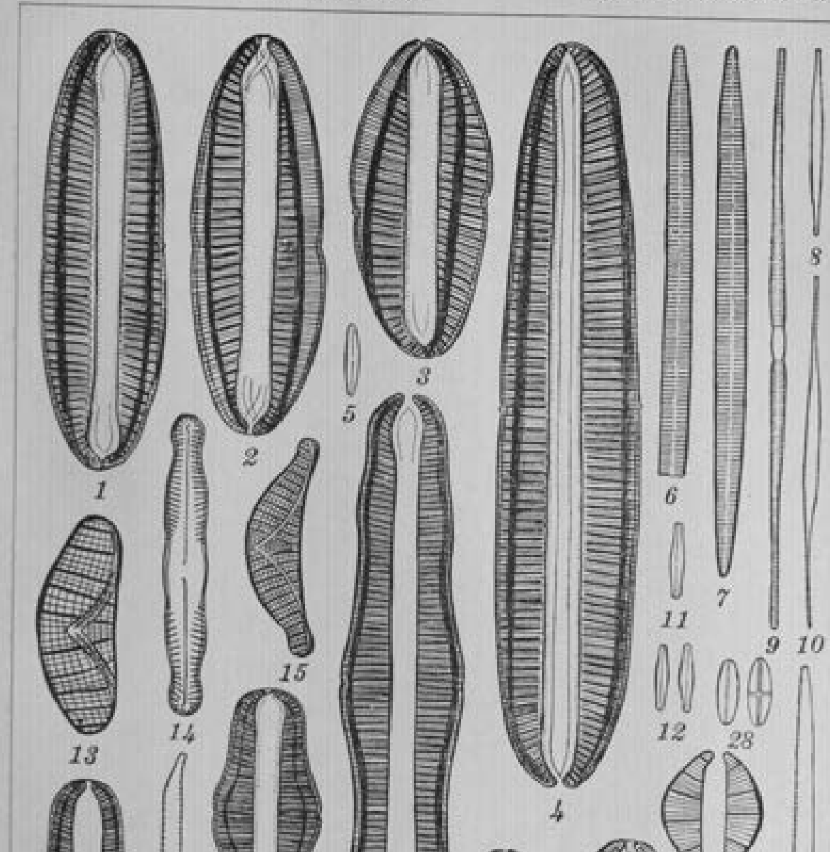
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PLATE 1.

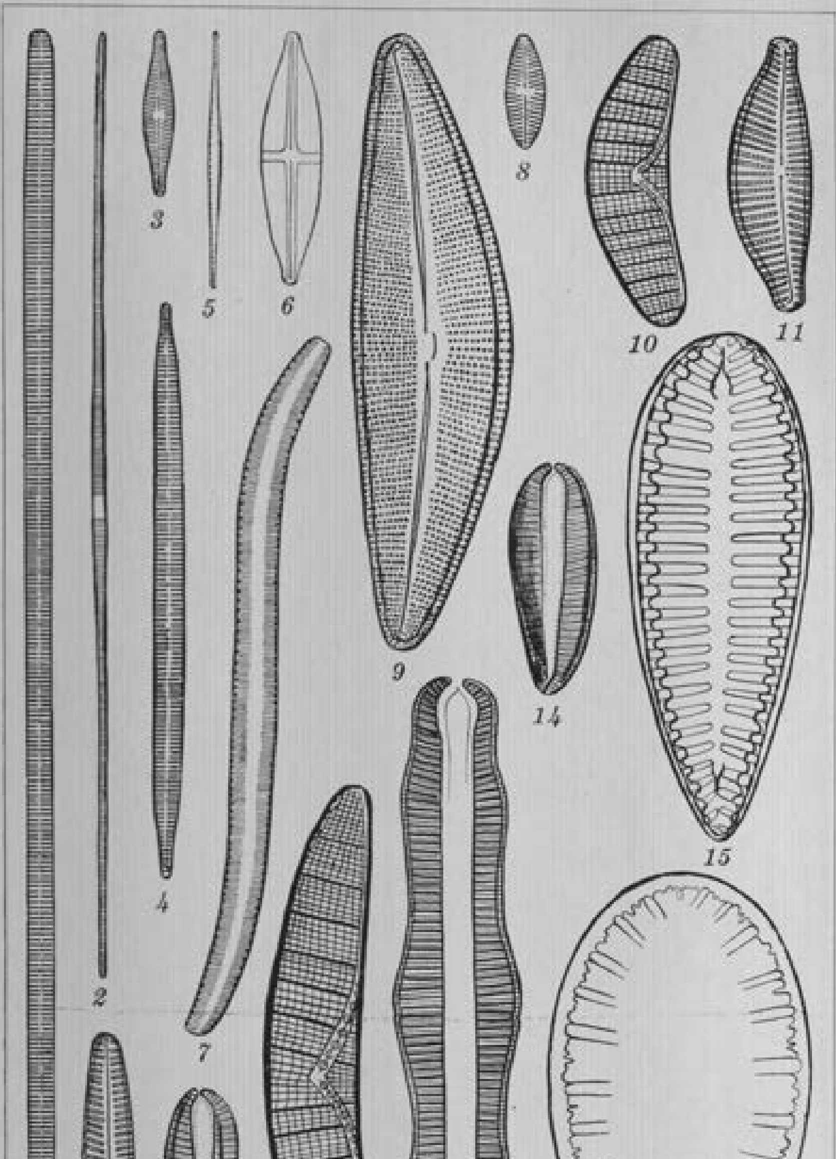

PLATE 2.

THE NAUCORIDÆ OF THE PHILIPPINE ISLANDS (HEMIPTERA)

By ROBERT L. USINGER

Of the University of California

ONE PLATE AND TWO TEXT FIGURES

The present paper is based largely on material collected by myself in Luzon, during a brief visit in July, 1936. My thanks are due to Mr. G. Bellosillo and Dr. Fidel del Rosario for a very profitable field trip to Montalban in Rizal Province, and to Drs. S. M. Cendaña and L. B. Uichanco, who contributed so largely to the success of my visit to Los Baños and Mount Maquiling in Laguna Province. Mrs. Frieda Abernathy meticulously executed figures 1 to 4, while the genitalia drawings were made by me.

Two species of the hemipterous family Naucoridæ have heretofore been recorded from the Philippine Islands. Both of these, *Naucoris obscuripennis* Stål (1854) and *N. seminiger* Lethierry (1877), were described from Manila and have not been compared with each other. They are discussed below, together with three apparently new species. The new species are of considerable significance, as they extend both the scope and the known distribution of their respective subfamilies considerably. Further significance of these collections lies in the suggestion of a rich and as yet untouched fauna in the more remote provinces of Luzon and on the other islands of the Philippine Archipelago. It becomes obvious that these interesting water bugs are of frequent occurrence in the Philippines, and it is hoped that collectors will devote more time to them in the future than has been their wont in the past.

NAUCORINÆ

NAUCORIS OBSCURIPENNIS Stål. Text fig. 1.

Naucoris obscuripennis STÅL, Öfv. Vet.-Akad. Förh. 11 (1854) 239; Freg. Eugen. Resa, Ins. (1859) 266; Enum. Hemipt. 5 (1876) 145.
Naucoris seminiger LETHIERRY, Bull. Soc. Ent. Franc. (5) 7 (1877) ci.

A single specimen collected in Molawin Creek on the Los Baños campus, July 17, 1936, in a quiet pool beneath some floating, dead vegetation. It is 7 millimeters long. The em-

bolium is pale, not only at the base, but along the entire margin, with the exception of apical sixth. The lateral pronotal margins anteriorly have a distinct, sinuate, black vitta extending from behind the eyes to the lateral margins. The mesosternum is strongly carinate at the center, the carina platelike, composed of a smaller anterior and a larger posterior lobe, rounded in profile and more strongly elevated posteriorly.

This specimen is smaller than Stål specified for his type (8 millimeters) and smaller than Lethierry's *seminiger* (7.5 millimeters). The black anterolateral pronotal markings would place it as *scutellaris* Stål in Stål's key (1876) but Lundblad has re-

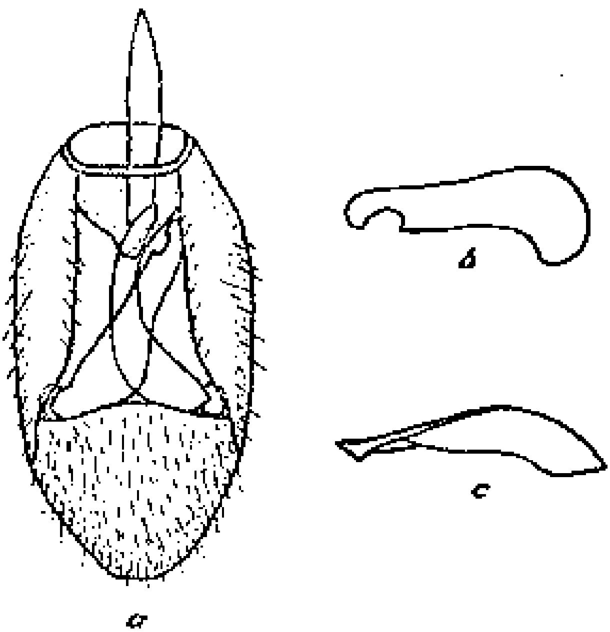

FIG. 1. *Naucoris obscuripennis* Stål, male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

cently shown (1933) that *scutellaris* is exceedingly variable, synonymizing Distant's *sordidus*, *rividus*, *greeni*, and *clathratus* with it. Such variation in a single species is indeed remarkable, and certainly minimizes the importance of color as a diagnostic character in this group. Other differences between *obscuripennis* and *scutellaris* are the smaller size of *scutellaris* (5 to 6 millimeters) and the male genitalia (text fig. 1) which, upon comparison with Lundblad's figures (1933, fig. 19), are seen to differ in certain respects. In *obscuripennis* the capsule (text fig. 1, *a*) is less narrowed and less strongly produced posteriorly, and the left paramere (text fig. 1, *b*) is differently

shaped and has fewer and smaller spines within the margin subapically. Considering their geographical distribution and apparently insignificant color and size differences, I venture to suggest that *obscuripennis* Stål is identical with *seminiger* Lethierry, although I have not examined either of the types.

NAUCORIS spp.

Three nymphs that may belong here were collected in swiftly flowing water of the river at Montalban Gorge. They were taken by disturbing rocks upstream and allowing the bugs to be swept down into the net. A single nymph of still another species was taken in some still water nearby.

CHEIROCHELINÆ

Genus ASTHENOCORIS Usinger novum

Oblong with sides subparallel. Superficially rugosely punctate. Head strongly produced beyond level of anterior margins of eyes; rather deeply inserted into anterior margin of pronotum which is trimarginate. Rostrum deeply inserted at base of a profound excavation of anterior half of head, the anterior portion of head extending as a plate beyond the much reduced, strongly transverse, apically rounded labrum. Subgenal plates prominent, forming elevated, anteriorly divergent continuations of the rounded posterior margin of the rostral excavation; exceeding tip of labrum but not extending anteriorly to anterior margin. Gula subacutely carinate at middle, tectiform. Antennæ very slender, proportion of segments 1 to 4 as 1.5 : 2.5 : 3.5 : 4, the first two segments thickest, shining, third and fourth segments linear, densely hairy. Eyes scarcely twice as long as greatest width, feebly lamellately produced laterally. Disc of head above with outline of base of rostrum visible, with a pair of oblique longitudinal lines on vertex, as in other members of the family.

Pronotum transverse, with lateral margins entire and posterolateral angles rounded. Disc with characteristic anterior depression ill-defined at middle, its sides anteriorly divergent but not reaching level of inner margins of eyes. An ill-defined longitudinal arcuate fascia behind each eye. A feeble subbasal transverse depression especially poorly indicated at middle. Hemelytra variously developed, entire to greatly reduced; when fully developed with a distinct clavus and embolium and with the membrane set apart from shagreened corium mainly by its shiny, subdepressed surface. Connexivum evenly rounded, the angles not or scarcely prominent laterally. Prosternum strongly

shaped and has fewer and smaller spines within the margin subapically. Considering their geographical distribution and apparently insignificant color and size differences, I venture to suggest that *obscuripennis* Stål is identical with *seminiger* Lethierry, although I have not examined either of the types.

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Pronotum transverse, with lateral margins entire and posterolateral angles rounded. Disc with characteristic anterior depression ill-defined at middle, its sides anteriorly divergent but not reaching level of inner margins of eyes. An ill-defined longitudinal arcuate fascia behind each eye. A feeble subbasal transverse depression especially poorly indicated at middle. Hemelytra variously developed, entire to greatly reduced; when fully developed with a distinct clavus and embolium and with the membrane set apart from shagreened corium mainly by its shiny, subdepressed surface. Connexivum evenly rounded, the angles not or scarcely prominent laterally. Prosternum strongly

elevated and carinate anteriorly, widened and depressed posteriorly; exposed throughout its entire length, the short, scarcely produced propleural plates scarcely covering its sides (Plate 1, fig. 2). Venter densely clothed with fine, moderately long hairs.

Front femora tremendously broad, three-fourths as broad as long. Anterior tarsi one-segmented, with a single extremely minute and very blunt claw at apex of each; both the tarsus and claw scarcely distinguished from arcuate tibia. Intermediate and posterior tibiæ with several rows of short, tawny spines, the posterior tibiæ, moreover, with dense swimming hairs on their dorsal surfaces. Intermediate and posterior tarsi each with two claws.

Genotype: *Asthenocoris luzonensis* Usinger sp. nov.

This genus is very different in general aspect from either *Cheirochela* or *Gestroiella*. It may be readily distinguished from both of these by its simple connexival angles, rounded posterolateral pronotal angles, and less strongly developed front legs. It is allied to the Bornean *Coptocatus* Montandon, from which it may be distinguished by its blunt, scarcely produced anterolateral pronotal angles, rounded sides of pronotum, distinct although greatly reduced labrum, and much smaller size. This interesting genus requires an enlargement of our concept of the subfamily Cheirochelinæ. The absence of a labrum was evidently an all-important consideration of Montandon's in thinking of this group. The present species, however, has the characteristic prolongation of the head, with the rostrum set in a deep excavation remote from its apex, while the labrum is moderately developed. I suspect from the description that Montandon's genus *Idiocarus* likewise belongs here. In *Idiocarus* the labrum is reduced and is concealed by the anterior prolongation of the head. The strongly produced subgenal plates considered to be of such great importance by Montandon in associating the genus with *Cryphocricos* are present, although variously developed, in all members of the family. They are prominent in *Asthenocoris*. This character then becomes merely one of degree, as in the American genera included in the Cryphocricinæ. That Montandon had only a hazy idea of the Cryphocricinæ is shown by his inclusion of *Pseudambrysus* (described on the next page to *Idiocarus*) in his monograph of the "Cryphocricinæ." He later (1897) concluded that *Pseudambrysus* was little more than a subgenus of *Macrocoris* in the subfamily Naucorinæ. Distribution lends added weight to

this theory, as *Idiocarus* at present is monotypic and is the only representative of the great *Cryphocricus-Ambrysus* group recorded from the Eastern Hemisphere. A study of Montandon's type will, of course, settle the question.

ASTHENOCORIS LUZONENSIS Usinger sp. nov. Plate 1, figs. 1 and 2; text fig. 2.

Oblong-oval with subparallel sides. Head transverse, 27 : 19, slightly longer than width of interocular space behind, 19 : 18; the inner margins of eyes straight, converging anteriorly; ratio of posterior to anterior interocular widths 9 : 7; almost as

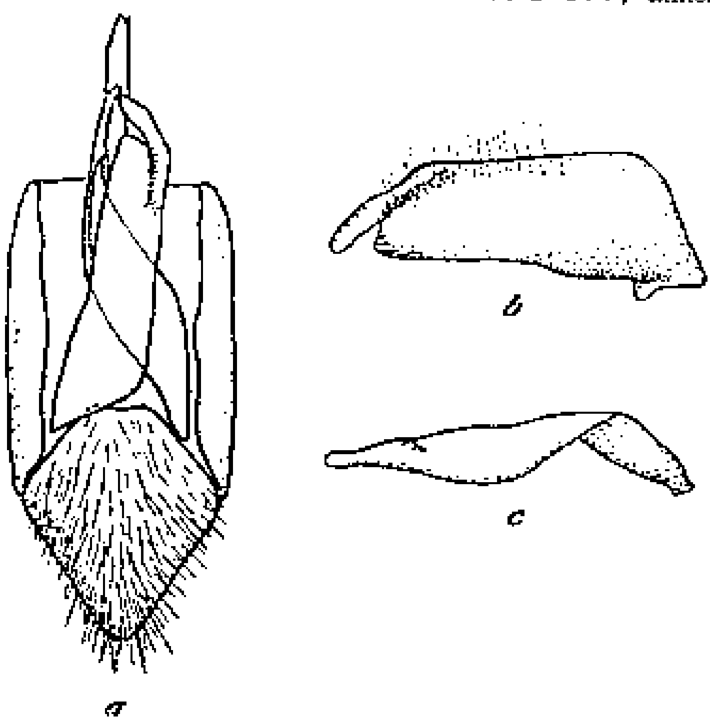

FIG. 2. *Asthenocoris luzonensis* sp. nov., male genitalia. a, Genital capsule, dorsal view; b, left paramere; c, right paramere.

strongly produced before the eyes as posterior insertion into pronotum behind the eyes, 4 : 5; disc moderately elevated basally and at middle, depressed anterolaterally and on anterior prolongation which is rounded anteriorly. Eyes a little less than twice as long as broad, broadest posteriorly where they are broadly rounded, subacute anteriorly; anterolateral margins feebly arcuate, very slightly but distinctly lamellately produced laterally over anterior angles of pronotum. Pronotum only

moderately convex, transverse, about one and one-half times as broad posteriorly as head including eyes; a little less than three times as broad as long; anterior angles almost right angles; sides strongly arcuate and narrowly carinate; posterolateral angles broadly rounded, subemarginate at level of emboliar margins; surface irregularly, very superficially punctate, transversely rugose anteriorly at middle; anterior border behind interocular space distinctly margined or ledged. Scutellum twice as broad as long, subbasally transversely depressed, sides feebly sinuate, disc irregularly, finely, rugosely punctate. Hemelytra not reaching apex of abdomen, scarcely exceeding apex of posteriorly produced, apically shallowly emarginate fifth abdominal segment, which is transversely rugose above. Commissure of clavus about one-third as long as scutellum. Embolium abruptly dilated at base, then subrectilinear and scarcely dilated to posterior third where it is broadly rounded and thence distinctly sinuate at joining with corium. Connexivum broadly exposed, the posterolateral angles right angles. Male genital capsule (text fig. 2, *a*) elongate-oval, rounded at apex, and with the median basal, dorsal lobe very short and moderately produced at middle. Parameres very prominent, asymmetrical, the left paramere (text fig. 2, *b*) with a rounded notch subapically and the right paramere (text fig. 2, *c*) angulately truncate at apex.

Color black, the interocular space except basally, pronotum except anteriorly and behind transverse impression, very narrow emboliar margin, commissure of clavus, connexivum obscurely except on posterior angles and narrow fulvous margins, underside of head, propleura laterally, and appendages yellow.

In the female allotype the hemelytra are much reduced, reaching only to posterior margin of fifth abdominal segment, the posterolateral angles of the pronotum are not emarginate, and the color is lighter. The exposed dorsal surface of the abdomen yellowish, irregularly spotted with fuscous and the coria each with a yellow spot at middle of apical margin.

Size.—Male, length 7.75 millimeters, width (at level of embolium) 4; female, length 7.08, width (as above) 3.17.

Holotype, male, No. 4236, in the type collection of the California Academy of Sciences Entomology, Los Baños, July 17, 1936 (*R. L. Usinger*). Allotype, female, No. 4237, California Academy of Sciences Entomology, same data as type and thirteen paratypes from the same series. This species was fairly common in the swiftly flowing portions of Molawin Creek,

where the specimens were collected amidst the rocks and smaller pebbles.

In the series of paratypes there is an amazing variability in development of hemelytra, no two specimens being exactly alike in this respect. There is no evident sexual correlation in wing development in the series before me, both the longest and the shortest winged specimens being males. In the shortest winged example the hemelytra reach only onto the base of the third abdominal segment. The pronotum in this case is considerably less developed posteriorly and the whole insect is more feeble. There is likewise a great deal of color variation, the black spots of the head and pronotum being more extensive in some examples, while there is often more yellow on the hemelytra.

APHELOCHEIRINÆ

Kiritshenko (1929) has recently summarized the distribution of this interesting subfamily. Since that time another species, *Aphelocheirus bianchii* from Turkestan, has been added by the same writer, Esaki has described another Japanese species, and I (1937) have described a new species, *A. australicus*, from Queensland, this being the first member of the subfamily from Australia and a considerable extension of the known range of the genus. With the description of the two species in the present paper a conspicuous gap is closed in the map of Kiritshenko, and further additions are to be expected with further collecting in the Philippines and further south.

APHELOCHEIRUS UICHANCOI Usinger sp. nov. Plate 1, fig. 1.

Oval, more broadened behind than in front. Color in great part black with the head and appendages yellow. Connexival angles only moderately produced.

Head large, slightly broader, eyes included, than long, 28 : 25; longer than width of interocular space in front, 25 : 22; the ratio of posterior to anterior width of interocular space 15 : 22; disc moderately elevated, finely punctate, the anterior border rather evenly rounded, produced before the eyes twice as far as posterior portion is produced behind the eyes. Eyes almost three times as long as broad, 15 : 6, rounded posteriorly, scarcely laterally produced at anterolateral angles. Antennal segments 1 to 4 in the proportion 1 : 3 : 3 : 5. Labrum less than twice as broad as long, rounded apically. Rostrum reaching intermediate coxæ, the second segment over three times as long as

third. Gula moderately tumid. Pronotum over three and one-half times as broad as long on median line, two-thirds as long as head; disc elevated at middle, transversely rugose anteriorly and posteriorly, irregularly so elsewhere; anterolateral angles right angles, rounded at apices; sides moderately, evenly arcuate, the posterolateral angles narrowly rounded; posterior margin straight, broadly and only moderately prolonged posteriorly over bases of hemelytra. Scutellum over twice as broad as long, subbasally transversely depressed, slightly produced at apex. Hemelytra very abbreviated, not reaching posterior margin of first visible abdominal segment, subrounded at apices, more or less truncate on inner halves of posterior margins; lateral margins briefly sinuate basally, feebly reflexed, evenly rounded slightly beyond curve of base of abdomen, then abruptly angled and strongly sinuate behind. Connexival angles scarcely produced on first visible abdominal segment, progressively more strongly produced posteriorly, the margins feebly but distinctly notched and spined just before the posterior prolongations; elsewhere along the margins, except on first segment, irregularly, minutely spined, the spines usually seven. Venter rather strongly, roundly elevated at middle, segments 4, 5, and 6, each bearing a very inconspicuous cluster of from four to six spines on its posterior border at middle.

Male genital segments with apical side pieces as seen from above moderately long, narrowed posteriorly, and rounded at apices.

Female genital plates almost as long as broad at base; posterior margins sinuate laterally and basally, roundly angled at basal third and very broadly and strongly reflexed and truncate at middle forming a small emargination at apex.

Color black, the disc of head except at base, pronotum obscurely at center and along lateral margins, scutellum at center, narrow abdominal margins, under side of head and thorax, and rostrum and legs fulvous to testaceous. Spines and claws tawny. The male is brownish rather than black with the hemelytra testaceous along the emboliar and scutellar margins.

Size.—Male, length 10.66 millimeters; width (at greatest width of connexivum) 6.50; female, length 10.83; width (as above) 7.08.

Holotype, female, No. 4238, California Academy of Sciences Entomology, collected in Molawin Creek where it runs through the campus of the Agricultural College at Los Baños, July 17,

1936 (*R. L. Usinger*). Allotype, male, Molawin Creek, Los Baños, P. I., April, 1927 (*L. B. Uichanco*), in my collection. An additional female (same data as type) and an additional male (same data as allotype) are in the collection at the College of Agriculture, Los Baños. It is with great pleasure that I dedicate this species to its first collector, the enthusiastic and accomplished Philippine hemipterist Doctor Uichanco.

The holotype, one paratype and a nymph, were taken in swiftly flowing parts of the creek amidst rather large rocks. They were kept alive for a time in a small container of water, where they lay motionless as though dead, until, with a sudden effort, they would make their way to the surface. At no time was a silvery air film to be seen covering the under side of the abdomen, as is typical of the surface-breathing naucorids.

A. uichancoi is related to *A. inops* Horvath but is at once distinguished by its larger size, abruptly angular margins of wing pads behind embolia, nonemarginate posterolateral angles of pronotum with short, rounded posterior projections of posterior margin before bases of wing pads and somewhat larger projections of connexival angles, especially on the fourth and fifth segments. It resembles *kawamuræ* Matsumura, which, however, has the head more strongly produced before the eyes and the connexival angles much more strongly produced.

APHELOCHEIRUS PHILIPPINENSIS Usinger sp. nov. Plate 1, fig. 3.

Elongate-oval, fuscous to testaceous, pronotal margins and abdominal margins, except at base, minutely dentate, teeth rather evenly, widely spaced.

Head transverse, 25 : 21, longer than anterior width of interocular space, 21 : 17; ratio of posterior to anterior width of interocular space 10 : 17; disc rather strongly elevated, finely rugose, with punctures basally and laterally; produced only twice as far before the eyes as behind the eyes; anterior margin rounded more strongly toward the sides. Eyes twice as long as broad, inner margins moderately rounded, outer margins more strongly so, anterolateral angles feebly, lamellately produced. Rostrum attaining middle coxæ, the second segment over three times as long as third, 24 : 7. Labrum twice as broad as long, rounded apically. Proportion of antennal segments 1 to 4 as 1.5 : 6 : 5 : 8.5. Gula only slightly tumid. Pronotum strongly transverse, almost four times as broad, posteriorly, as long on median line, 51 : 14; two-thirds as long as head on median line; transversely rugose, especially anteriorly and posteriorly

at middle, elsewhere finely punctate; anterolateral angles little more than right angles, subrounded; sides moderately, evenly arcuate with twelve minute, evenly spaced teeth on dorsal edge; posterolateral angles subangular, rounded at apices; posterior margin scarcely arcuate, with short rounded projections at bases of wing pads. Scutellum strongly transverse, almost three times as broad as long, 29:11, transversely depressed at base. Hemelytra not reaching posterior margin of first visible abdominal segment, rounded apically; emboliar margin sinuate and reflexed basally, thence strongly, roundly dilated, behind which it is subangulately truncate; margin behind this rather strongly sinuate. Abdominal margins except on basal segment with about six minute, evenly spaced spines per segment; posterolateral angles of segments little more than right angles except on last two segments which are bluntly produced in the female. Abdomen beneath strongly, roundly elevated at middle, especially posteriorly, the fourth, fifth, and sixth segments bearing from four to six spines, transversely arranged near posterior margins at middle.

Male genital segments with apical side pieces visible from above long and slender, slightly exceeding tip of genital capsule, evenly narrowed posteriorly and rounded at apices.

Female genital plates almost as long as broad at base, the posterior margins subangular at basal third, abruptly angular on either side, near apex forming a small, triangular emargination at middle.

Color fuscous to black, the pronotum laterally, scutellum, hemelytra except submarginally, narrow connexival margins, genital segments, and under side in great part fulvous to testaceous. Ventral surface laterally glaucous to lurid. Rostrum and spines of legs and abdomen fulvous. Female with interocular space laterally and under side of head testaceous.

Size.—Male, length 7.92 millimeters; width (at greatest width of connexivum) 4.92; female, length 8.75; width (as above) 5.25.

Holotype, male, No. 4239, California Academy of Sciences Entomology, taken in Molawin Creek on the slopes of Mount Maquiling just beyond the mud spring, July 19, 1936 (*R. L. Usinger*). Allotype, female, same locality as type, July 18, 1936, in my collection. Both of these specimens and a single nymph were found after a diligent search in the swiftest part of the stream.

This species is doubtless very closely allied to *Aphelocheirus uichancoi;* but it is superficially very different and may be distinguished at once by its smaller, more slender form, lighter color, hemelytral and connexival margins, and genitalia. It is likewise allied to *A. inops* Horvath but has the posterior margin of the pronotum angulately emarginate near lateral angles. The lateral margins of embolia are not sinuate on basal third in *A. inops,* the female genital lobes are rounded laterally and do not form a small emargination at apex, and the male lobes do not reach the level of the apex of the genital capsule.

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ILLUSTRATIONS

PLATE 1

FIG. 1. *Asthenocoris luzonensis* sp. nov., dorsal view of male.
2. *Asthenocoris luzonensis* sp. nov., ventral view of male.
3. *Aphelocheirus philippinensis* sp. nov., dorsal view of female and terminal abdominal segments of male.
4. *Aphelocheirus uichancoi* sp. nov., dorsal view of female and terminal abdominal segments of male.

TEXT FIGURES

FIG. 1. *Naucoris obscuripennis* Stål, male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.
2. *Asthenocoris luzonensis* sp. nov., male genitalia. *a*, Genital capsule, dorsal view; *b*, left paramere; *c*, right paramere.

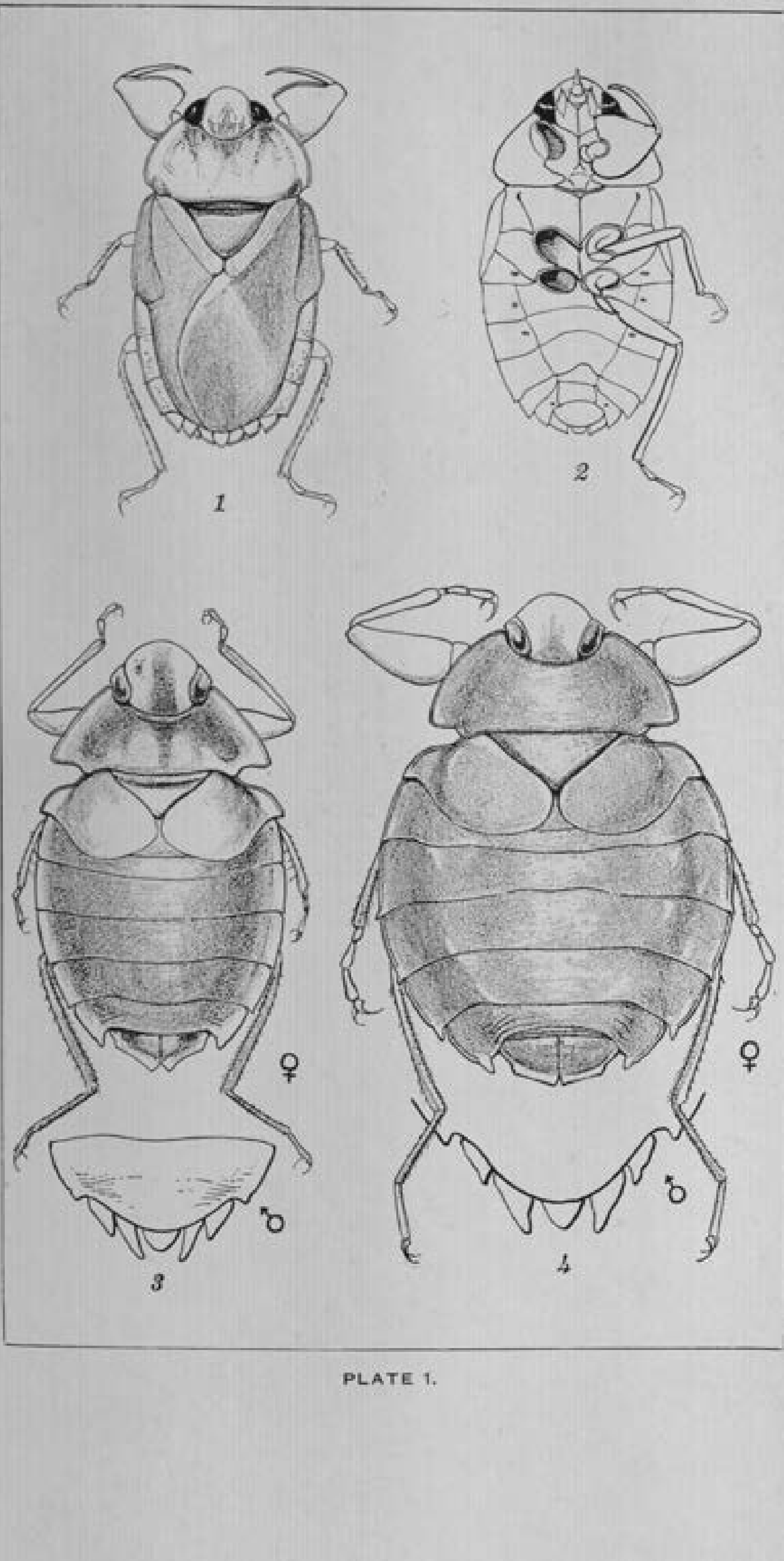

PLATE 1.

THE REMONTADOS OF RIZAL PROVINCE [1]

By Generoso S. Maceda

Of the National Museum Division, Bureau of Science, Manila

FOUR PLATES

Of all the pagan groups of the Philippine Islands, the Remontados, otherwise known as the Pagan Tagalogs, are the most peace-loving, although they are the descendants of the outlaws of Christian towns, who fled to the mountains to evade payment of taxes during the Spanish regime. Unlike other pagan groups, they have abandoned their lawless life and have become useful citizens. Kindness, friendliness, and trustworthiness characterize their dealings with both mountaineers and lowlanders.

At present the Remontados dwell chiefly in the eastern part of Rizal Province, particularly in the barrios of Sta. Ines, Antipolo municipality; Tinukan, Mamuyao, San Andres, Cuyambay, Layban, Daraitan, and Sampaloc, Tanay municipality; and Macabod, Anginan, Cabooan, Mabolo, Malasia, and Puray, Montalban municipality. Table 1 shows their distribution.

TABLE 1.—*The distribution of the Remontados in Rizal Province.*[a]

Barrio	Municipality	Male.	Female.	Total.
Santa Ines	Antipolo	185	143	329
Cuyambay	Tanay	140	153	293
San Andres	do	76	73	149
Tinukan	do	73	72	145
Mamuyao	do	115	111	225
Layban	do	135	231	366
Daraitan	do	129	139	268
Sampaloc	do	153	120	273
Macabod	Montalban	99	67	165
Anginan	do	44	39	83
Mabolo	do	45	42	87
Malasia	do	28	26	54
Cabooan	do	30	35	65
Puray	do	79	68	147
Total		1,331	1,319	2,660

[a] Prepared under the direction of Mr. Claro Samonte, superintendent of the Remontados of Rizal Province, as of December 19, 1935.

[1] The writer wishes to express his sincere appreciation of the coöperation given by Mr. Claro Samonte, superintendent of the Remontados, and his assistant, Mr. Perfecto Villamor, in the preparation of this manuscript.

Although the Remontados are generally inclined to a seminomadic life, steady invasion on the part of the lowlanders forces them to permanent settlement in and around their clearings; otherwise, their kaiñgins would be absorbed by the invaders.

"Remontados" is derived from the Spanish verb *remontar*, meaning "to frighten away." Many of the people now designated by this term are the descendants of former townspeople who left their towns and fled to the mountains to live as outlaws, rather than to pay tribute to the Spanish government, and because they had little liking for so-called civilized life. Beyer says of this group "Most writers have casually dismissed them as descendants of remontados, or outlaws from the Christian towns, who have fled to the hills and there mixed with wandering bands of Negritos."[2] Sawyer adds: "The tendency of the Philippine native to revert to old customs is well marked, and I agree with Jagor when he says: 'Every Indian has an inmate inclination to abandon the hamlets and retire into the solitude of the woods, or live isolated in the midst of his own fields,' in fact to *remontar*."[3]

Physical characteristics.—The Remontados are of mixed blood. Their physical characteristics show two distinct influences, Dumagat and Tagalog. According to Prof. H. O. Beyer they are predominantly of the short Mongol physical type, mixed with Negrito and lowland Filipinos of the vicinity.[4]

Generally they have well-developed extremities by reason of their industrious everyday life.

Ornaments and bodily decoration.—The Remontados are very fond of adornment, and readily spend their savings for this purpose. On special occasions, like fiestas and marriage feasts, they dress in their beautiful costumes and display their bejuco rings decorated with orchids, seeds, fruits, and rare forests flowers, to win the admiration of the opposite sex.

Tattooing is practiced by the Remontados, who call this practice *cadlet*. A pointed piece of metal is used in the process, and powdered charcoal serves as pigment.

They also grind the incisal edge and the anterior surface of their front upper teeth in order to give them uniformity in length and a concave appearance.

[2] Population of the Philippines in 1916, Manila (1917) 60, 61.

[3] The Inhabitants of the Philippines (1900) 210.

[4] Population of the Philippines in 1916, Manila (1917) 61.

Language.—The Remontados speak a language that is purely Tagalog, although intonational differences may be observed among the different groups. The differences may be attributed to intermarriage with both the Dumagats and the lowland Tagalogs.

Political life.—The Remontados, like their Christian neighbors, have a definite and established form of political organization, the officers of which are the president, the vice president, the councilors, the secretary, the chief of police, and the members of the police force. All these officers are elected by open vote, supervised by the superintendent. Each barrio elects its own officers, whose duties are merely to pass ordinances pertaining to the public works of the barrio concerned. Much of the life of the Remontados is regulated by old customs and traditions, which are closely observed and seldom violated.

Food.—The staple food of the Remontados is rice, supplemented with root crops, corn, bananas, and papayas, which are all grown in the kaiñgins of the group. Remontados have a peculiar method of cooking rice, called *binoko;* that is, boiling the rice in bamboo tubes. Other foods of the Remontados are the flesh of various forest animals; such as monkeys, deer, wild hogs, and chickens; and river fishes, such as eels, mudfishes, and shrimp (*sugpo*).

Their methods of catching wild hogs and monkeys are interesting. For the former they use the *balaes*, and for the latter, the *pakuis*. The balaes is a trap set on the ground where the trails of the wild pigs are. It consists of a long wooden pole bent into a bow, one end of which is provided with a piece of *caña boho* to serve as the point of an arrow. The other end of the pole is fastened on two pieces of wood driven into the ground two feet apart. These two pieces of wood are the main holders of the formed bow. A hook holds the end of the bow where the arrow is attached, and a piece of vine is tied on the hook. The length of the vine depends upon the radial reach of the bow, one end of which is provided with the decoy, usually cassava roots. When the wild boar eats the decoy, the hook jerks and suddenly releases the bow. The arrow is thrust into the wild boar's trunk by the flexible force of the bow. Usually the animal is not instantaneously killed, but merely weakened, so that little chasing ends the game.

The *pakuis* is a snare set up on the ground to trap monkeys. It consists of a post about two meters high driven into the ground. Another piece of wood is tied on top of the post in an inclined position. A rattan loop is formed at the upper end of the inclined piece of wood. In front of the loop the decoy, usually fruits, is provided to attract the hungry monkeys. Below this setting, a heavy log is suspended, connected with the formed loop. The suspended log forming the lower part of the apparatus is thickly covered with rattan spines, so as not to give way to the animal except towards the loop. As soon as the animal picks up the decoy, the suspended log drops down and the loop strangles the victim against the inclined log.

Eels and mudfishes are also caught in a peculiar manner; namely, by means of the implements composing the catapult, the dart, and the goggles. The chaser dives into the water with the apparatus, locates the holes where the fishes are hiding, and then thrusts the dart into the holes.

Housing.—There are three distinct types of houses, as shown in Plate 1, figs. 2 to 4. The materials used in the construction are: Tree trunks, caña boho, rattan, and cogon grass. Usually, the houses are very low. When cogon grass is not available, divided caña boho is used for the roof and along the sides. The house is usually entered by means of detachable ladders which are removed when the family is away, to keep out animals.

Fire making.—The Remontados have two primitive methods of producing fire, the firesaw and the *pinkian* (flint and steel). The firesaw method involves the rubbing of the edge of split bamboo over another piece in a horizontal position. Bamboo shavings are placed between, and rubbing continues until the shavings combust by friction. Ignited shavings are then blown into a flame. The pinkian is an ensemble of flint, steel, and *okipan*, fine dried husk of palm trees which burns readily. The steel is struck against the flint and the resulting sparks igniting the akipan are blown into a flame.

Industries.—The Remontados have very few industries. They have no knowledge of pottery. A little mat, hat, and basket weaving is done. Agriculture is carried on according to the kaiñgin system. Trade with the lowlanders in rattan, vines, almaciga, and other forest products is also a source of income to them.

Family life.—The Remontados are monogamous. The discovery of adultery, which very seldom happens, results in the

separation of the husband and wife. The dowry and all the marriage expenses of the couple are returned by the offending party to the offended, but if this is not accomplished, the alternative is the death of the guilty party.

Marriage.—Marriage, called *pagbabalae*, is performed by parental arrangement. The families of the boy and the girl make the contract of marriage when the children are still quite young. When the boy and the girl reach puberty, the parents of the girl ask of the young man's parent a certain amount of money, ranging from 10 pesos to 100 pesos. This sum is locally termed *bilang*, or dowry. Aside from the dowry the girl is provided with clothes, and her parents with rice and working animals. The last that the parents of the boy provide is the house where the couple is to live permanently.

On the day of marriage the bride dresses in the house of one of her nearest relatives. The bridegroom then fetches her and they walk along the street to the bride's house. The relatives of the bride kneel on the street as the couple passes by and beg from them rice and wine. When they reach the house, an old man performs the marriage ceremony and counsels the couple loudly in the following words:

"Kayong mga anak ay kaawawa at kayo ay mahihiwalay na upang mamahay na ng sarile. Huag na ninyong uugaliin ang pagkabata, kung hindi parang sa matanda na at kung dumarating ang inyong mga magulang ay inyong pakakanin at pañgañgañgain." (I pity you children, you are separating from your parents to live independently. Do not be childish anymore but behave like the old folks and when both your parents visit you, offer them food and buyo.)

After that counsel the couple is considered married.

The poor Remontados do not adhere to these marriage rites. The poor man and woman, after obtaining parental consent, live together as husband and wife.

Children.—Customarily the child is born in the home of its parents. The mother gives birth in a squatting position. The midwife who take charge of the delivery is usually an old woman, assisted by the husband. The husband is always present, because it is believed that if he is absent the wife will encounter hardships in the delivery of the child.

Amusements.—Dancing the *fandango* is an indispensable part of every feast among the Remontados. Love *kundimans* are sung to the guitar. The Remontados are very fond of music,

so that even at work or while walking they cannot help but sing. The songs that they sing are locally known as *ilda*. Some of the beautiful passages of the *ilda* in rhyme are here quoted:

"Ako ay paalam malantik na ñgipin, sa iyo naman vivo kung tumingin." (As he bids goodbye to the lady with concave teeth, the man look at her vividly.)

"Kung ako ay titigan ng maamo mong mata, daig ang salapi at badlang gayuma." (I do not listen to money and charms when you look at me with your wistful eyes.)

Sickness and cure.—Unlike other groups of mountain people, the Remontados regard their diseases as physical in nature. They do not believe that sickness is caused by certain evil spirits whom they have unintentionally offended. To cure their ailments, they resort to many kinds of roots, leaves, and fruits of plants.

Skin disease, called *buni*, is very common. Malaria, and enlargement of the neck and the stomach, are other diseases prevailing in their community.

Death and burial.—The Remontados believe that when a person dies his spirit will return. *Bibit* is the local term for the spirit of the dead. They further believe in a life hereafter.

If a person dies, he is buried in the very place where he expired. There is no cemetery provided for the dead. The house inhabited by the deceased is burned, for it is believed that his spirit will return to it.

The burial ceremony is short and simple. It is performed by an elder man who recites the following:

> Iiwan namin ang aigala at lalamnan ng iyong ngangangain at ikukuha ka namin ng pagkain mo pagkat hindi ka na makakain ng pagkain natin dahil sa ikao ay namatay na. Sayang ka naman at hindi mo na makakain ang iyong pinag paguran at ikao ay pagtatapusan namin sa mga lingong arao. Kami ay aalis na dito sa iyong kinamatyan at aming susunugin pagkat kami ay bibibiten. (We are leaving the wallet with buyo and we will provide you with food because you will not be able to eat your share with us and by next week we will celebrate the ninth night of prayer for you. We will destroy our house otherwise your spirit may visit us.)

Then all persons present at the ceremony sing the song for the dead called *dalet*. This dalet is repeatedly sung for nine nights successively.

> Liko liko ka man sapa dati kitang binabanka, doon dao ay may lanka matamis dao pati satla.
>
> Langit langit na maitim ibababa ka na namin at sa Dios iaalay namin upang sa pagkakasala'y patawarin.

(You will pass a meandering stream and you will reach the place where sterile carpels of jackfruits are also sweet. Clowdy sky, we are lowering the deceased and we will pray God to pardon him for his sins.)

The relatives of the deceased visit the resting place, bringing food and other offerings on the third day. To know if the spirit of the dead visited the house where the nine nights of prayer were held, they spread ashes on a winnowing tray at the entrance of the house. This is done on the fourth night after the interment. The following morning the tray is examined, and if the surface of the layer of ashes seems disturbed, it is said that the spirit had returned in the night. As a matter of fact the disturbance may have been caused by domestic animals roaming about the house at night.

ILLUSTRATIONS

PLATE 1

FIG. 1. A Remontado village.

FIGS. 2 to 4. Three types of Remontado houses.

PLATE 2

FIG. 1. A Remontado couple.

2. A Remontado *fandanguero*.

3. Remontado traders and children, showing the manner of carrying burdens on the back suspended from the head with straps.

PLATE 3

FIG. 1. A Remontado president.

2. A Remontado woman.

3. A Remontado man, showing his bejuco armlet.

PLATE 4

FIG. 1. The biggest Remontado family in a village, consisting of 10 children.

FIGS. 2 and 3. Groups of Remontados of barrio Layban, Tanay, Rizal Province.

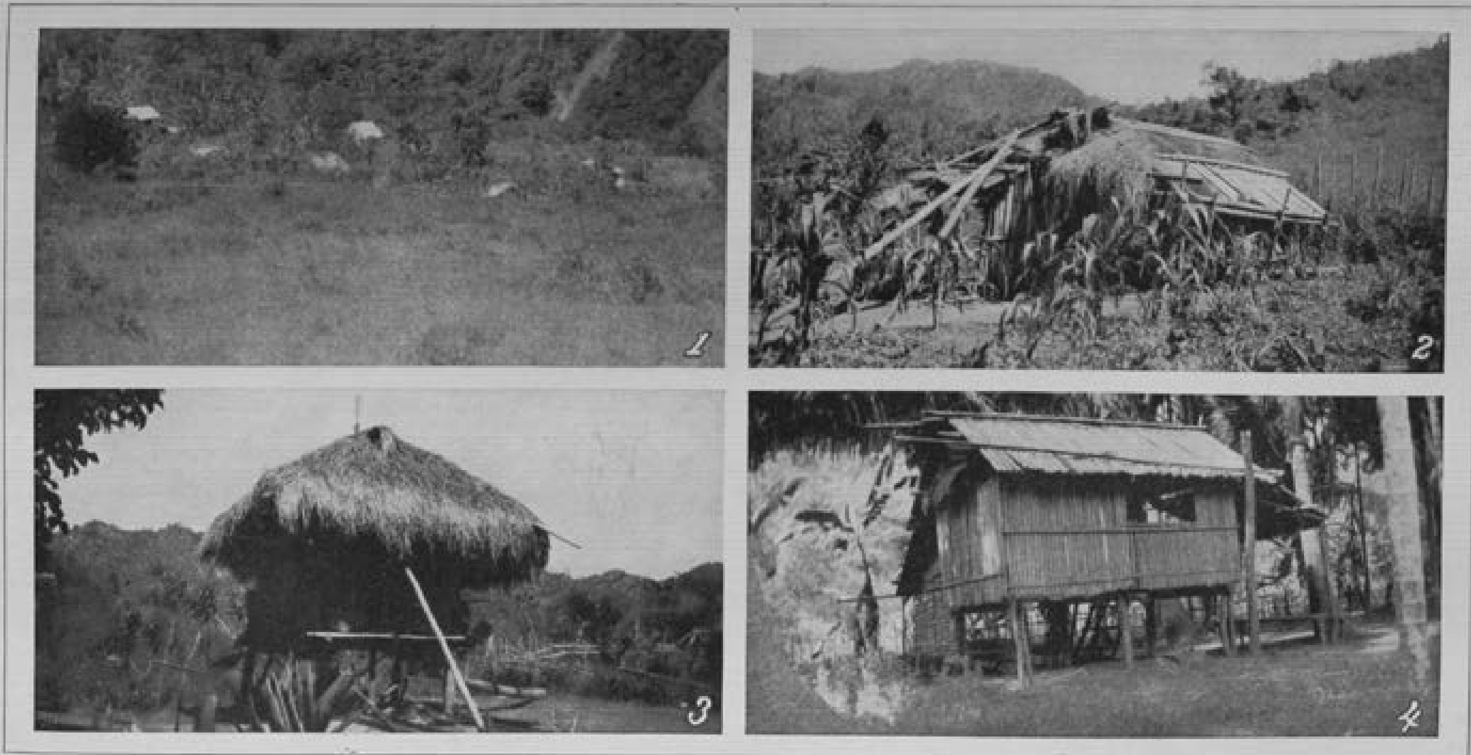

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American Institute of mining and metallurgical engineers. Petroleum division. Transactions, vol. 123. Petroleum development and technology, 1937. New York, The Institute, 1937. 689 pp., illus., tables. Price, $5.

CHALMERS, LEONA W. The intimate side of a woman's life. Foreword by W. S. Pugh. Radio City, New York, Pioneer publications, Inc. 1937. 126 pp., illus. Price, $1.50.

DAVIS, ROBERT H. Deep diving and submarine operations; a manual for deep sea divers and compressed air workers. London, The Saint Catherine press, 1937. 510 pp., illus., photographs. Price, 18s.

FROIN, G. Pression solaire. Faisceau énergétique et biologie biogenèse et pathogenèse. Paris, Librairie Girardot et Cie, 1937. 327 pp., illus. Price, 30 frs.

HACKETT, LEWIS WENDELL. Malaria in Europe; an ecological study. London, Oxford University press, 1937. 336 pp. Price, $3.75.

HISCOX, GARDNER DEXTER. Henley's twentieth century book of formulas, processes and trade secrets; a valuable reference book for the home, factory, office, laboratory and the workshop; containing ten thousand selected household, workshop and scientific formulas, trade secrets, chemical recipes, processes and money saving ideas for both the amateur and professional worker; revised and enlarged edition by T. O'Conor Sloane. New York, Norman W. Henley publishing company. 1937. 832 pp., illus. Price, $4.

JOYEUX, CH., and A. SICÉ. Précis de médecine coloniale. 2d ed. Paris, Masson et Cie, 1937. 1250 pp. Price, 170 frs.

MANSFIELD, WILLIAM. Materia medica, toxicology and pharmacognosy. St. Louis, The C. V. Mosby Company, 1937. 707 pp., illus. Price, $6.75.

MONRO, C. C. A. Polychaeta. The John Murray expedition, 1933–34, Scientific reports, vol. 4, no. 8. London, The British Museum (Natural History), 1937. pp. 243–321, illus. Price, 5s.

MORRISON, A. CRESSY. Man in a chemical world; the service of chemical industry. New York, Charles Schribners' sons, 1937. 292 pp. Gratis.

NEEDHAM, JAMES G., and others. Culture methods for invertebrate animals. A compendium prepared coöperatively by American zoölogists under the direction of a committee from Section F of the American Association for the Advancement of Science. Ithaca, Comstock publishing company, 1937. 590 pp., illus. Price, $4.

OTTER, G. W. Rock-destroying organisms in relation to coral reefs. Great Barrier Reef Expedition, 1928–29, Scientific reports, vol. 1, no. 12. London, British Museum (Natural History), 1937. pp. 323–352, plates, illus. Price, 5s.

PAGÉ, VICTOR WILFRED. Ford V 8 cars and trucks; construction—operation—repair; a most complete and practical manual explaining the construction of all parts of late model Ford automobiles with instructions for driving, servicing and repairing; written in simple language; a universal book of reference; illustrated by many specially made diagrams and distinctive original photographs of actual parts furnished by the factory service department. New York, Norman W. Henley publishing company, 1937. 720 pp., illus. Price, $2.50.

POPPE, THOMAS WILLIAM, and H. P. STRAND. House wiring; a treatise; describing and illustrating up-to-date methods of installing electric light wiring, bell and telephone wiring and burglar alarm wiring; intended for the electrician, helper and apprentice, fully illustrated by 191 original engravings. 8th ed. rev. and enl. New York, Norman W. Henley publishing company, 1937. 256 pp., illus. Price, $1.

SHEPHARD, C. Y. The Cacao industry of Trinidad; some economic aspects. Series II–IV. Trinidad, Government printing office, 1936. 2 vols. Copies of these publications may be obtained on application to the Editor, "Tropical Agriculture," Imperial College of Tropical Agriculture, Trinidad, B. W. I. Price, 7s.

SWEETMAN, HARVEY L. The biological control of insects; with a chapter on weed control. With a foreword by L. O. Howard. Ithaca, Comstock publishing company, Inc., 1936. 461 pp., illus. Price, $3.75.

United fruit company. Research Department. Nutritive and therapeutic values of the banana; a digest of scientific literature. Boston, United fruit company, 1936. 143 pp. Gratis.

REVIEWS

Adolescence; A Study in the Teen Years. By Lawrence Augustus Averill. Boston, Houghton Mifflin Company, 1936. 496 pp. Price, $2.25.

As one of the most recent, it undoubtedly is the most interestingly written of the books dealing with that most revolutionary period of life, adolescence. The book is different from most textbooks on the subject in that the author "has paid little attention to theories" but has instead, according to the author's preface, "endeavored rather to present the adolescent individual as a living, striving, flesh-and-blood person whose growth and development are in considerable measure determined by the nature of the parental, social, and community influences that surround him."

The author presents in case studies adolescent behavior and conduct. This makes the book interesting reading from beginning to end. The book is recommended to all who deal with adolescents, whether at home, at school, or in the community.

Parents especially should find this book not only delightful reading but also instructive in problems dealing with their children's behavior.

This book has fourteen chapters. Some of the chapters that should be of interest to every one are: Crime and Delinquency; The Parent and the Adolescent; The School and the Adolescent; The Role of Sex in Adolescence; The Adolescent's Religion.

—S. G. P.

Applied Soil Mechanics. By William S. Housel. University of Michigan, Civil Engineering Department, 1933. 94 pp., illus., plates. Mimeographed. Price, bds. $4.40.

A comprehensive treaty on applied soil mechanics, useful to the highway and construction engineers in general and agricultural engineers in particular. The historical development of the subject is well discussed in the first chapter.

In a lengthy discussion the author makes a very clear exposition of the subject on pressure distribution with well-selected analogy. The theory of soil resistance and methods of measurement covers the rest of the book. The book is furnished with illuminating illustrations, tables, and diagrams.—D. Z. R.

Asia Directory; A Complete and Up-to-date Guide to the Principal Manufacturers, Exporters, Importers, Merchants, Shipping and Insurance Companies, Banks, Commercial and Governmental Organizations, etc. in the Japanese Empire, British India, Burma, Ceylon, China, the Dutch East Indies, French Indo-China, Hawaiian Islands, Hongkong, Kwantung, Territory, Manchoukuo, Philippine Islands, Siam, Straits Settlements; Classified according to Commodities and Trades, and Arranged Alphabetically for Rapid Reference. 1936–37 Edition. Yokohama, Japan, The Asia Directory Publishing Company. Price, Y15.

The editor of the Asia Directory says in his preface that he has endeavored not only to fulfill the need for a genuinely up-to-date and comprehensive business directory but "also to provide a link between potential buyers and sellers, so that they may get into direct touch with one another." In order to check up personally the entries in the Directory, Mr. R. Mori, the editor, travelled extensively in all the countries dealt with, except North China and Manchoukuo.

This directory is of particular value only to those interested in Japanese products, as it deals with manufacturers, exporters, and merchants in 22 important cities in Japan. The Directory covers the Japanese Empire more extensively than the other countries. More than half of the whole volume is devoted to the Japanese Empire alone.

The indices given are; Index to Towns; Index to Countries, Towns, etc.; Index to Names of Advertisers; and Index to Trade Headings for the Japanese Empire only. The page numbers do not run consecutively throughout the book, each country being given new pagination.

The book should be in the office of every commercial firm importing Japanese products. Exporters and importers will find it a good source of information in establishing trade relations with Japan and other oriental countries.—P. S. S.

Disability Evaluation; Principles of Treatment of Compensable Injuries. By Earl D. McBride. Philadelphia, J. B. Lippincott Company, 1936. 623 pp., illus., tables, diagrs. Price, $8.

This is a reference book of extraordinary exhaustiveness. It contains careful description of the most common injuries and disabilities following industrial accidents, and also extended discussion and practical consideration of the ways of appraisal or evaluation of these disabilities. The description of the suggested treatment and methods of rehabilitation is clear and logical. This books should be in the library of every practicing surgeon. —J. I. A.

Experimental Studies on a Transmissible Myelomatosis (Reticulosis) in Mice. By Otto Kaalund-Jørgensen. Acta Radiologica, Supp. XXIX. Copenhagen, Levin & Munksgaard, 1936. 142 pp., plates, tables. Price, Swedish cr. 12.

This monograph gives the results of an experimental investigation on the nature, histology, and mode of propagation of a transmissible myelomatosis in mice. The disease is compared with the filterable fowl leukoses, the transplantable mammalian tumors, the transmissible leukoses, and the human leukoses. Among the important findings recorded is that the mouse myelomatosis differs from the leukoses of fowls by its nontransmissibility by a cell-free agent. In this respect it resembles the mammalian tumors, but differs from them in being a systemic generalized disease which cannot be transmitted by intravenous inoculation.—M. T.

Factor Table, Giving the Complete Decomposition of All Numbers Less than 100,000. Prepared Independently by J. Peters, A. Lodge, E. J. Ternouth and E. Gifford, and Collated by the British Association Committee for the Calculation of Mathematical Tables. (British Association for the Advancement of Science. Mathematical Tables, vol. 5). London, Office of the British Association, 1935. 291 pp., tables. Price, 20s.

A factor table is of great value to those engaged in mathematical calculations. A glance at these tables of the British Association for the Advancement of Science reveals painstaking and laborious effort in producing this very handy and valuable table for mathematicians.—J. C. E.

Farm Organization and Management. By G. W. Forster. Ann Arbor, Michigan, Edwards Brothers, Inc., 1935. 210 pp. tables, illus. Price, $3.

The author, G. W. Forster, Agricultural Economist, North Carolina State College of Agriculture, University of North Carolina, has had actual farm experiences in several parts of Canada and the United States, and also 15 years of teaching and research experience. In this book he has integrated the general economic principles as they apply to farm management and sound farm practices, making it very satisfactory for teaching purposes. It is divided into two parts—the first part dealing with the organization of the farm and the second part with its management. Types of farming and farm records have been omitted in the text to give way to those subjects which deal primarily with the organization and management of individual farms.

The most important feature of the book is that the author always supports his ideas with either tabulated or graphical illustrations, and every chapter is followed by a set of questions which are very helpful to a ready understanding of the subject. To teachers and students of agricultural economics, farm managers and administrators, agricultural leaders, and those actively engaged in similar undertakings, Farm Organization and Management is a valuable book.—H. S. S.

German Agricultural Policy, 1918–1934. The development of a National Philosophy Toward Agriculture in Postwar Germany. By John Bradshaw Holt. Chapel Hill, The University of North Carolina Press, 1936. 240 pp., maps. Price, $2.50.

This book is a comprehensive presentation of Germany's agricultural policy during the postwar period, from 1918 to 1934. It was presented as a dissertation for the degree of doctor of philosophy at the University of Heidelberg, Germany. It is composed of four parts.

The first part discussed the farm policy of a socialistic, economic-political group—the Social Democrats. Legislative measures were enacted between 1918 and 1920, defining the farm

policy of the Social Democratic Party, which emerged from the Council of People's Commissars of the Revolution, as it was consistent with its desire to socialize and democratize both labor and capital for the benefit of the consumers.

Part 2 deals with the return to liberalism. The consumers demanded cheap foodstuffs and low taxes, while the producers strove for high prices. On account of the changed composition of the Reichstag, where the producers had the upper hand, the government abolished the food administration in 1923 and approved measures for low taxes.

Industrial control, federalization, and the Farm Revolt are the subjects treated in the third part. Continuing the enforcement of the Land Settlement Act there was effected a big redistribution of lands, so that from 1919 to 1932 about 4 per cent of the estates in the northern provinces were redistributed in the form of small family subsistence farms. The Government agricultural price policy became more complicated, as it had to deal with such difficult phases as farm credit, protective tariff, and control of food consumption.

The last part presents the rule of National Socialism in regard to agriculture. In 1933 the National Socialism Party came into power. In accordance with the Party's 1930 program, the Government gave the farmers absolute protection against any threat of depression. The export industry of Germany was sacrificed to protect the domestic farm prices. In fact, the policy adopted was of a national-racial character; and the party in power was ready to decide on all questions involving not only economic, but also social and political as well.

The book is very instructive and should be read by all those concerned with the formulation of Government agricultural policies.—H. S. S.

Individual Psychology: Theory and Practice. By C. M. Bevan-Brown, G. E. S. Ward, and F. G. Crookshank. London, The C. W. Daniel Company, Ltd., 1936. 79 pp. Price, paper, 2s 6d.

The pamphlet contains a series of articles on the theory and practice of individual psychology. The first article, by Dr. C. M. Bevan-Brown, Chairman of the Medical Society of Individual Psychology of London, is really his presidential address. It is a plea for correlation of the various schools of psychoanalysis of Freud, Jung, and Adler.

The second article, "Heart and Mind," by Dr. G. E. S. Ward, a cardiologist, discusses the 'supreme importance of the state of mind of the patients' when dealing with cardiac cases.

The reader who is not acquainted with psychological literature will wonder what individual psychology is. This series of articles will give the reader some idea of this school of psychology, founded by the late Dr. Alfred Adler, the internationally known physician and psychologist.—S. G. P.

Land Settlement: A Report Prepared for the Carnegie United Kingdom Trustees. By A. W. Menzies-Kitchin. With a Foreword by the Trustees. Edinburgh, T. and A. Constable, Ltd., 1935. 175 pp., tables. Gratis.

This book presents an exhaustive study of land settlement problems in Great Britain. It was the assigned task of the author to suggest plans for a new land settlement program. In the preparation of his report to the Carnegie United Kingdom Trustees, Mr. Kitchin gathered an immense amount of information in the course of his trips to many parts of England and Scotland, supplemented by data obtained while making personal visits to certain sections of three leading countries in Continental Europe. In this particular field of economics, Mr. Kitchin's work can hardly be excelled in thoroughness of treatment and in carefully reasoned arguments that led him to draw the conclusions he did. The reader should examine the report and the "foreword" by Mr. Elgin representing the trustees, contained in the same volume. It will be seen that while the trustees differed from Mr. Kitchin on one vital point—the size of holding most appropriate for settlement—it would be conceded that the author was justified in making the deduction strictly from the economist's viewpoint. Upon a broad consideration of the various questions involved, the author finally arrived at a few specific conclusions, of which the proper size of holding for the unemployed laborer is of utmost importance.—H. S. S.

Modern Views of Atomic Structure. By Dr. Karl Rast. Translated from the German by Dr. W. O. Kermack. London, Frederick Muller, 1935. 156 pp., illus. Price, 7s 6d.

As stated in the translator's preface, this book gives an account, in nonmathematical language, of the advances which have been made in recent years in the domain of atomic theory, with special reference to that problem which is of fundamental

importance to the chemist, namely, the essential nature of the periodic system of the elements. Some of the more important advances that have been made since the original German text was published are also included.

Various topics, such as Avogadro's number, the structural units of the atom, quantum theory and numbers, periodic system, X-Ray spectra and electro-magnetic mass are discussed and explained in a most interesting and popular style.—A. P. W.

An Outline of Malayan Agriculture. Compiled by D. H. Grist. (Malayan Planting Manual No. 2) Published by the Dept. of Agriculture, Straits Settlements and Federated Malay States, Kuala Lumpur, 1936. 377 pp., illus., maps, plates. Price, $3.

In the treatment of the agricultural conditions of Malaya, the author has a complete view of the development of the geographical conditions, climate, geology and soils, and also the development of politics, communications, populations, and agricultural industries. Treatises on land tenure, agricultural policy, agricultural population and Malayan agricultural service, are complete, although not in detail, and contain the most essential and fundamental facts needed by students of the subject. In the second chapter, where methods of cultivation and soil treatment are emphasized, the tools and their use for each individual crop or plant are described in detail. In the third, each major crop of Malaya such as rubber, coconuts, rice, oil palms and pineapples, is treated separately. How these plants are treated in Malaya, including income which is the most important part of any commercial undertaking, is discussed in this chapter in detail for the information of all.—M. B. R.

Précis de Parasitologie. By E. Brumpt. 5th Edition. Paris, Masson et Cie., 1936. 2 vols., v. 1, xii + 1082 pp.; v. 2, 1083–2139 pp. Illus., plates. Price, 200 frs.

The Précis de Parasitologie is one of the few much appreciated books on parasitology, and the author should be congratulated for this fifth revised edition. As now presented, it has all the admirable qualities of the fourth edition and includes much of what has recently been brought to light as the result of the researches of the numerous workers scattered to the four corners of the world. The illustrations are excellent. Volume 1 devotes about one hundred pages to general problems in parasitology, followed by discussions on the spirochætes, Protozoa, trematodes, cestodes, and nematodes. In volume 2 the annelids, arthropods, and fungi of medical importance are taken up.

—M. T.

Psychology in Questions and Answers. By Rev. Hilarion Duerk. New York, P. J. Kenedy & Sons, 1936. 230 pp. Price, $1.50.

This book is a welcome addition to the many publications already in existence concerning the science of psychology. The method of presentation is quite unique, and simple enough to be understood by lay readers. The title of the book, however, is slightly misleading, for it deals not with the Science of psychology as viewed today by modern psychologists, but with psychology from the standpoint of scholasticism or Catholicism. Thus, to the first question, "What is Psychology?" (page 3) the author answers "Psychology is the science of the soul and its operations or functions through the organisms of the body." Modern psychologists have long ago given up the soul as the subject matter of psychology.

Another example: Question 88 (p. 38) "Does the infant at birth possess an intellect and a free will?" Answer: "The infant from the first moment of conception, according to the more scientific opinion of psychologists, possesses an intellect and free will . . ." "Now, just who are the psychologists whose scientific opinions are referred to?" If the author refers to the scholastic psychologists he is right, but if he refers to the rank and file of modern psychologists the answer is hardly tenable.

The books is, however, intended for students of Catholic institutions. As such it is important, because it presents psychology from the scholastic point of view. The reviewer recommends it, however, to all psychologists in order that they may rightly understand Catholic psychology.—S. G. P.

Psychology of Sex; A Manual for Students. By Havelock Ellis. New York, Emerson Books, Inc., 1937. 377 pp. Price, $3.

This is a well-written manual intended especially for medical students, but it may be profitably used by all students of sex psychology. It is clear and instructive. Although new terminologies are introduced which at first sight may seem strange and foreign to the student, their simple explanation and definition make them easily understood.

The author opens to the student a panoramic view of sex knowledge and its psychology from the earliest philosophers to the modern psycho-analysts. He gives a perspective, clear and encouraging, which only an author of wide experience and knowledge can give. With a bold conclusion he confirms the ideas of other investigators and gives hope to victims of neuroses

due to bad effects of masturbation which are more imaginary than real.

A striking treatment of the subject is the lengthy discussions of normal conditions. The abnormal is dealt with sufficiently to be clearly understood.

In his conclusion he offers no definite remedy for abnormal sexual psychic conditions, although he points out that sublimation may be utilized as one of the promising and effective ways of diverting excess sex impulse. Other supplementary treatments will have to be continued in dealing with sex perversions.
—U. D. M.

Soil Science; Its Principles and Practice Including Basic Processes for Managing Soils and Improving their Fertility. By Wilbert Walter Weir. (Lippincott's Agricultural Science Series) Chicago, J. B. Lippincott Company, 1936. 615 pp., maps, illus. Price, $3.50.

The author of this book has presented a bird's eye view of soil science. A historical development of agriculture and the rise of scientific thought is well treated in the first chapter. The following chapters cover all branches of soil science—chemical, physical, biological, irrigation and drainage, erosion, soil classification, mapping, fertilizers, and others. A wealth of references is listed at every end of the chapter. Tables, illustrations, and pictures made clear some of the interesting facts mentioned.

The chapter on the modern concept of soils discusses briefly the position of soil as an independent, natural, historical body.

This book will make an excellent textbook for students in agricultural colleges. Each subject is treated well and briefly in simple language within the grasp of any undergraduate student.—D. Z. R.

Studies on the Ætiology and Pathogenesis of Cataracta Zonularis. An Academic Treatise by Gunnar von Bahr. Upsala, Almquist and Wiksells Boktryckeri, 1936. 236 pp., plates, diagrs.

This work is a detailed study on the ætiology and pathogenesis of zonular cataract. The morphology, cause, and pathogenesis of this form of cataract are well reviewed, giving special emphasis on the element of heredity in the formation of the type of cataract. Tetany is an important factor in the formation of this opacity of the lens, more so in cases with certain nutritional deficiencies, such as rickets. The formation, once it has begun, will continue in spite of the disappearance of the

tetany. The opacity appears like vacuoles containing an opaque substance. Decrease in the calcium content of the blood does not predispose the case to formation of this lamellar cataract.
—C. D. A.

The Study of the Soil in the Field. By G. R. Clarke. Published under the auspices of the Imperial Forestry Institute, University of Oxford. Oxford, Clarendon Press, 1936. 142 pp. Price, 5s or ₱2.50.

This book gives a comprehensive and concise description and method of studying the soil in the field. As a guide to a soil scientist in the field it gives in detail the fundamental factors required in field observation. The first three chapters deal mainly with the fundamental principle of gathering data in the field.

The chapter on soil survey and mapping describes briefly the steps necessary before going to the field. The last chapter gives a panorama of the various soil-survey systems of several countries. This book should be in the possession of every soil scientist, especially the field man.—D. Z. R.

Training in Industry: A Report Embodying the Results of Inquiries Conducted Between 1931 and 1934 by the Association for Education in Industry and Commerce. Edited by R. W. Ferguson. London, Sir Isaac Pitman and Sons, Ltd., 1935. 156 pp. Price, $1.75.

This book is a general summary of inquiries made in the course of three years from about forty firms and industrial concerns. It is edited by R. W. Ferguson whose work with the Association for Education in Industry and Commerce in England is well known.

The report, consisting of 87 pages, is, as stated in the introduction, a statement of fact and a record of experience, rather than an exposition of theories. The Appendices, in 69 pages, giving the schemes of educational training adopted by fourteen large industrial concerns in England, are instructive and interesting reading. References on the methods used in selecting new employees are also given in the Appendices.

While the book is of particular value to executives of industrial and commercial establishments, it is also of interest to our authorities in connection with vocational education programs of the government. College and university authorities giving commercial and technical courses will find it instructive reading.—A. S. A.

Yeast Fermentation and Pure Culture Systems. By Stephen Laufer and Robert Schwarz. New York, Schwarz Laboratories, Inc., 1936. 112 pp., illus. Price, $2.50.

This monograph is a practical and yet scientific treatise on yeasts. As stated in the author's preface, it "is intended to serve the practical brewer as a manual that will furnish him the most important information regarding fermentations." It is a very readable book. In going from page to page one cannot help but admire the dexterity of the authors in presenting in such limited space so much valuable information. Both students and professionals will find it a good addition to their lists of references.—M. B.

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